

FIELD INSTRUCTIONS

FOR FOREST INVENTORY

ROCKY MOUNTAIN AREA

Intermountain Forest and Range Experiment Station
Ogden, Utah

Rocky Mountain Forest and Range Experiment Station
Fort Collins, Colorado

U. S. Forest Service Regions 1, 2, 3, and 4

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FOREWORD

It is expected that within the states of the Rocky Mountain area^{1/} two types of forest surveys will be carried on:

1. A sampling survey designed to meet the minimum needs of the Forest Survey.

2. A more intensive sampling survey designed to provide greater accuracy and more detail at local levels. The degree of intensification will depend on the amount of cooperation forthcoming from National Forest Administration, other Federal agencies, states, and private sources. It is expected that intensification will usually take the form of a complete forest type map of the lands in which the cooperator is interested plus an increase in the intensity of the volume sample.

This manual of instructions is intended to govern field work on both types of surveys in the Rocky Mountain area. From time to time supplements and revisions needed to cover specific conditions will be issued for addition to this manual.

This manual has been written so that sections dealing with specific phases may be removed and used separately if desired.

All personnel engaged in any phase of the field work of this project are expected to become familiar with the procedures and definitions set forth in this manual and to follow them at all times.

No departure from these instructions will be permitted unless specifically authorized by the field supervisor. This is necessary to assure uniform procedure by all personnel.

^{1/} Includes Utah, Wyoming, Colorado, Nevada, Arizona, New Mexico, Montana, Idaho, and South Dakota.

PURPOSE

The purpose of this forest inventory is to collect basic information on forest land area, timber volume, growth, and mortality for the Forest Survey as authorized by the McSweeney-McNary Forest Research Act of May 12, 1928, and subsequent amendments.

In addition to being used to analyze the timber resource situation in the immediate area, the information collected will be combined with data from other areas to present the regional and national timber resource picture.

GENERAL PLAN

SURVEY METHOD

The survey method described here applies generally to the extensive inventory conducted under the National Forest Survey Project. This survey will be intensified wherever cooperative assistance is available. Such intensification will require modification in the survey method and will be covered by supplemental instructions.

Area Sample

Area estimates of forest land will be determined through sampling on strips of aerial photographs. Generally three methods will be considered:

1. Mapping along strips.
2. Mapping of blocks on strips of aerial photos.
3. Classification of dots on strips of aerial photos.

The method selected will depend on the type of terrain, continuity of forest land, and quality of aerial photographs available.

Area Sample

Area estimates of commercial forest land by counties, working circles, logging units, forest types, stand-size class, crown density, and ownership class will be determined from a complete forest cover type map of the cooperative project area. Noncommercial forest land within the project area will be broken down by productive and nonproductive, ownership class, and forest type.

The maps will be prepared on aerial photographs and checked where necessary and whenever possible in the field by a combination of ground and air methods. The photo mapping phase will precede field work. A preliminary estimate of area to be used in distributing volume sample will be made by dot count on the aerial photos prior to field work, usually before transferring the data to the map sheets.

Three- or 4-color printed township-size cover type maps at a scale of 2 inches equal 1 mile will be prepared by Region 2.

Area estimates will be obtained for commercial and noncommercial forest land. Estimates of area of commercial forest land will be compiled at the county level by type, stand-size class, crown density, and ownership class. Noncommercial forest land areas will be compiled at the county level by forest type and whether productive or nonproductive.

Inventory Field Sample

Volume, growth, quality, species, diameter distribution, and mortality data will be obtained from measurements on field plots located at random within the various sampling strata. All of the above information except mortality will be collected on pairs of circular 1/5-acre permanent plots established at the prescribed locations pricked on the aerial photos. Mortality data will be obtained from pairs of circular 1/3-acre plots having the same centers as the volume and growth plots.

Estimates of total volume, mortality, and growth will be products of area and mean-volume-per-acre by stratum (all ownerships). The mean-volume-per-acre estimates will be computed from field plot measurements using International Business Machines.

Estimates of defect and log quality will be computed by applying percentages to the volume totals. The percentages will be derived from measurements on the sample plots.

SAMPLING ERRORS

Maximum sampling error limits at state levels for the Forest Survey are:

Area -

Commercial forest land $\pm$ 3% per million acres (1 standard error)

Noncommercial forest land $\pm$ 10% per million acres (1 standard error)

Volume - Regions 2, 3, 4 $\pm$ 12% per billion cubic feet (1 standard error)

Region 1 $\pm$ 10% per billion cubic feet (1 standard error)

Growth - Regions 2, 3, 4 $\pm$ 12% per billion cubic feet (1 standard error)

Region 1 $\pm$ 10% per billion cubic feet (1 standard error)

ORGANIZATION

Supervision of the Forest Survey in Regions 1, 2, 3, and 4 is the responsibility of the Forest Survey Unit through the Intermountain and Rocky Mountain Forest and Range Experiment Stations. A close liaison between the Forest Survey and National Forest Administration will be maintained.

A field supervisor, headquartered at a strategic location, will be in immediate charge of the field crews. This field supervisor will provide direct technical supervision of the field crews, assigning their areas of work and checking their work for maintenance of quality and quantity standards.

Two-man crews will be used to establish and measure the sample plots. Ordinarily 2 to 4 men will constitute a field party. One man of each party will be designated as party chief and will be responsible for the daily scheduling of the work of the crew members and their adherence to the Survey instructions.

Inventory Field Sample

The accuracy desired for management plan surveys is considerably greater than the Forest Survey requires. Therefore additional volume sample plots must be installed and measured to attain this accuracy. All volume sample plots will be located, established, measured, and recorded according to the Forest Survey standards and procedures.

SAMPLING ERRORS

In that this survey must meet the requirements for preparation of timber management plans, sampling errors within the cooperative project area will be considerably lower than for the Forest Survey. Maximum sampling errors to be achieved on the cooperative project are:

Area - No sampling error (100 percent map)

Volume - 5 percent per national forest (1 standard error)

10 percent per working circle within a national forest
(1 standard error)

DEFINITIONS AND SPECIFICATIONS

GENERAL

Sample Plot

The unit of area on which all inventory, growth, mortality, salvage, quality, and defect data are measured and recorded. Each sample plot consists of four concentric circular subplots as follows:

1/500 acre - Live seedling-sapling trees, 1/2' high to 4.99" dbh incl.

1/50 acre - Live poletimber trees, 5.0" - 10.99" dbh incl.

1/5 acre - Live sawtimber trees, 11.0" / dbh

- Salvable dead trees, 5.0" / dbh

1/3 acre - Mortality trees, 5.0" / dbh

Forest Survey Plot

A sample plot where all measurements are taken: Inventory, growth, mortality, salvage, defect, quality.

Location

The point, pricked on the photo and located on the ground, at which a pair of permanent circular sample plots is located, measured, and recorded. Each location is given a number and the two circular sample plots are given the location number and the plot numbers 1 and 2, thus 005-1, 005-2. The point pricked on the photo will be circled on the back of the photo and numbered with the location number.

Reference Point

A prominent cultural or topographic feature in the proximity of the location and near which some object, usually a tree, may be identified precisely on the photo. This point marks the beginning of the course to

the location. It should be plainly marked on the ground, pricked and identified on the back of the photo by a circle, and a description of it and directions for reaching it entered on the Sample Plot Record. Commonly referred to as the RP.

Sampling Unit

The geographical unit of area for which the survey is set up to give a specified sampling error.

Sampling Point

An open-centered cross printed on the photos. Three or more sampling points are printed on each photo. These sampling points are used to obtain a preliminary estimate of area by stratum. They also indicate the possible points on a photograph which may be selected for a ground volume sample.

LAND USE CLASSES

Forest Land

Includes (a) lands which are at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime, (b) land from which the trees described in (a) have been removed to less than 10 percent stocking but which has not been developed for other use; (c) afforested areas, and (d) chaparral areas which have a crown closure of 50 percent or more. The minimum area for classifying forest and nonforest is 5 acres. Stringer types must be at least 120 feet wide regardless of length in order to qualify as forest land. In addition roads, streams, canals, rights-of-way, clearings and treeless strips within the forest but less than 120 feet wide are also considered forest land.

Commercial

Forest land which is (a) producing, or physically capable of producing, usable crops of wood (usually sawtimber); (b) economically available now or prospectively; and (c) not withdrawn from timber utilization. All commercial forest land will be subdivided into the types, stand-size classes, and stocking classes shown on pages 10-11 and 13-15.

Noncommercial

Two general kinds of noncommercial forest land are recognized, productive and nonproductive:

Productive - Public forest land withdrawn from timber utilization through statute, ordinance, or administrative order but which otherwise qualifies as commercial forest land. Productive noncommercial forest land will be subdivided into the same forest types, stand-size classes, and stocking classes as commercial forest land. (See pages 10-15.)

Unproductive - Forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions, or so physically inaccessible as to be unavailable economically now or prospectively.

Unproductive noncommercial forest land will be subdivided into the forest types shown on pages 12 and 22.

How to recognize - Because the classification, noncommercial forest land, includes several types of forest land a simple and precise definition is difficult to write. Within this category are included forest lands capable of producing sawtimber but unavailable for harvest by reason of dedication to some other purpose. Also included are forest lands incapable of producing sawtimber. Further, lands producing or capable of producing sawtimber but impossible to log now or prospectively are also included.

Application of the term noncommercial to these several types of forest land complicates further any definition that might be offered. Each area under consideration must be judged separately on its own characteristics. Fieldmen should visit local cutting operations to obtain a gauge of the kind of forest land being cut over today by commercial operators. A fairly safe assumption is that stands similar to those being cut are operable under present economic and technologic conditions and are therefore in the category of commercial forest land. There are, however, exceptions even to this. The fieldman should seek decisions on particular forest areas, and use these as case examples when judging areas in the future.

As aids in recognizing noncommercial forest lands use the following examples:

1. Land that is growing or capable of growing sawtimber but is not available for harvesting because of official dedication for some other purpose. This is productive noncommercial forest land.

2. Small blocks of forest land that are completely surrounded by terrain that prohibits harvesting economically are noncommercial. They are also called unproductive from an economic standpoint. To be called commercial the block of timber must be large enough and have species of sufficient value to stand the cost of road construction or installation of a Wyssen or some other system of cable logging. Remoteness alone is not an acceptable reason for calling an area noncommercial. Remember, roads will be built and new and cheaper methods of logging and transportation will be developed that will make presently remote areas economic to operate in the future.

3. There are areas producing good individual trees but are so strewn with boulders or cliffs that logging is impossible. Such areas are non-commercial.

4. Other areas do not have the soil, water, weather, aspect and other factors needed for growing usable sawtimber. These are probably the easiest to recognize. The timber is short, scrubby, slow growing, and few, if any, of the stems will make a sawlog. These forest areas are quite often at high elevations. They may be extremely valuable for watershed, grazing, or other purposes.

Nonforest

Land that does not qualify as forest land. Includes land which has never supported forest growth; land from which the forest has been removed to less than 10 percent stocking and has been developed for other uses, such as grazing, agricultural, residential, or industrial; all land in thickly populated urban or suburban areas, and water classified by the Bureau of the Census as land. Roads, streams, canals, rights-of-way, clearings and treeless strips within the forest zone must be at least 120 feet wide to qualify as nonforest land. The minimum area is 5 acres.

Nonforest land within the forested zone will be designated by the classes and symbols on pages 12 and 22.

COVER CLASSES

Commercial Forest Types

Basis for Classification

The species having the predominance of cubic-foot volume of sawtimber trees in sawtimber stands, pole trees in poletimber stands, or number of stems in seedling-sapling stands will determine the type designation. Where no species comprises 50 percent or more of the stand, the stand should be typed on the basis of the plurality of cubic-foot volume or number of trees. For example, a stand having 55 percent of its cubic-foot volume in Douglas-fir trees would be typed as Douglas-fir. A stand having 40 percent of its cubic-foot volume in ponderosa pine, 30 percent in Douglas-fir, 15 percent in lodgepole pine, and 15 percent in white fir would be typed as ponderosa pine.

Generalized Western Types

Douglas-fir - Forests in which 50 percent or more or a plurality of the stand is Douglas-fir.

Hemlock-Sitka spruce - Forests in which 50 percent or more of the stand is western hemlock and/or Sitka spruce.

Ponderosa pine - Forests in which 50 percent or more or a plurality of the stand is ponderosa pine.

White pine - Forests in which 50 percent or more or a plurality of the stand is western white pine.

Lodgepole pine - Forests in which 50 percent or more or a plurality of the stand is lodgepole pine.

Larch - Forests in which 50 percent or more or a plurality of the stand is western larch.

Fir-spruce - Forests in which 50 percent or more or a plurality of the stand is true fir (Abies spp.), Engelmann spruce, or Colorado blue spruce, singly or in combination.

Hardwoods - Forests in which 50 percent or more or a plurality of the stand is aspen, cottonwood, or other western hardwoods, singly or in combination.

Commercial aspen forest land is defined as: (a) Aspen areas obviously capable of growing thrifty stands with some trees of sawtimber size; (b) areas on which poor quality aspen is found but which by evidence on the ground may indicate the capability of reverting to conifer stands of commercial character. Judge capability by presence of conifer understories and intermingled trees; or occupancy of similar sites and aspects as adjacent commercial conifer stands.

Local Types

The local commercial forest types and symbols and the corresponding generalized Forest Survey types are:

<u>Local type</u>	<u>Map symbol</u>	<u>IBM Code No.</u>	<u>Corresponding generalized western region type</u>
Douglas-fir	D	01	Douglas-fir
Western hemlock	WH	48	Hemlock-Sitka spruce
Mountain hemlock	MH	47	Hemlock-Sitka spruce
Ponderosa pine	P	11	Ponderosa pine
Western white pine	WP	14	Western white pine
Lodgepole pine	LP	15	Lodgepole pine
Whitebark, limber, and bristlecone pine	WLP	26	Lodgepole pine
Western larch	L	55	Larch
White fir	WF	31	Fir-spruce
Grand fir	GF	33	Fir-spruce
Alpine and corkbark fir	AF	36	Fir-spruce
Engelmann spruce)			
Colorado blue spruce (	S	41	Fir-spruce
Black Hills spruce)			
Dead spruce	DS	49	Fir-spruce
Western redcedar	C	54	Western white pine
Hardwoods - Aspen	A	73	Hardwoods
- Cottonwood	Co	75	Hardwoods
- Other hardwoods	OH	70	Hardwoods

Noncommercial Forest

Aspen - Noncommercial aspen forest land is defined as aspen areas obviously incapable of producing thrifty aspen stands or of being capable of reverting to conifer stands of commercial character.

Chaparral - Lands supporting heavily branched dwarf trees or shrubs, the crown canopy of which covers more than 50 percent of the ground and whose primary value is watershed protection. The common chaparral constituents are species of Quercus, Cercocarpus, and Ceonothus. Extensive areas of species of Acer, Salix, and Prunus approaching tree form may also be included. Types dominated by the semi-desert shrubs or species such as Artemisia, Purshia, and Gutierrezia, are not considered chaparral.

Pinyon-Juniper - Noncommercial pinyon-juniper forest land includes all pinyon-juniper forests in which 50 percent or more of the stand is pinyon pine and/or juniper.

Other - All other noncommercial forest land regardless of cover type.

Nonforest Classes

Nonforest land within the inventory area will be classified as:

Water - Water bodies less than 40 acres.

Other - All other nonforest land. Includes agricultural and grazing land, brushland, residential and industrial areas, etc. (See definition of nonforest land page 9.)

STAND-SIZE CLASSES

Sawtimber

Stands with a minimum net volume per acre of 1500 board feet, International 1/4-inch rule, in trees of sawtimber size (11.0" / dbh).

Large sawtimber - Stands in which the majority of the net board-foot volume is in trees which are 21.0 inches dbh and larger.

Small sawtimber - Stands in which the majority of the net board-foot volume is in trees less than 21.0 inches dbh.

Poletimber

Stands failing to meet the sawtimber stand specifications, but at least 10 percent stocked with poletimber and larger (5.0 inches dbh and larger) trees and with at least half the minimum stocking, or 5 percent, in poletimber trees (5.0 inches to but not including 11.0 inches dbh).

Stands which are 10 percent or more stocked with sawtimber and poletimber trees, but with less than 1500 net board feet per acre Int. 1/4-inch rule and with few or no poletimber trees will not be classed as poletimber areas. Such areas will be classed as either seedling-sapling or nonstocked according to the definition of these classes.

Seedling-Sapling

Stands not qualifying as either sawtimber or poletimber stands, but having at least 10 percent stocking of trees of commercial species and with at least half the minimum stocking, or 5 percent, in seedling-sapling trees (1/2 foot high to, but not including, 5.0 inches dbh).

Nonstocked and Deforested

Areas not qualifying as sawtimber, poletimber, or seedling-sapling stands, i.e., normally less than 10 percent stocked. May in some cases include areas more than 10 percent stocked, e.g., stands more than 10 percent stocked with sawtimber trees but with insufficient board-foot volume to qualify as sawtimber stands.

Nonstocked and deforested areas will be classified by the latest forest type which occupied the area.

STOCKING CLASSES

Stocking is the extent to which growing space is effectively utilized by present or potential growing stock trees of commercial species. Stocking may be measured in terms of number of trees, volume, basal area, crown cover, or other criteria or combination of criteria. In the area covered by this manual sawtimber stands will be classed as to stocking on a dual crown cover basis. Poletimber and seedling and sapling stands will be classed as to stocking on the basis of crown closure of all trees, except where the crowns of trees are too small to see on aerial photographs, in which case the number of trees, as determined by ground check, will be the basis for estimating stocking class.

Crown Closure Specifications (or number of trees)

Nonstocked - 0 - 9 percent stocked

Poorly stocked - 10 - 39 percent

Medium stocked - 40 - 69 percent

Well stocked - 70 / percent

Stocking Specifications by Stand-Size Classes

Sawtimber Stands (Dual Classification)

Crown density by all trees

Crown density by sawtimber trees only.

Example: P9A WM - Ponderosa pine, small sawtimber, well stocked by all trees, medium stocked by sawtimber trees

Poletimber Stands

Crown density estimate by all trees of the stand

Example: LP8 W - Lodgepole pine, poletimber stand, well stocked by all trees

Seedling-Sapling Stands

Crown density by all trees or number of trees in the stand

Example: AF7 W - Alpine fir, seedling-sapling stand, well stocked by all trees.

MINIMUM AREAS

All the area will be delineated by the foregoing classes to the following minimum areas:

Contrasting Conditions

5-acre minimum area

Forest versus nonforest

Commercial forest versus noncommercial forest

Softwoods versus hardwoods

One stand-size class to another two steps removed, e.g., poles versus large sawtimber, seedling-saplings versus small sawtimber, nonstocked versus pole stands.

One density class to another two steps removed, e.g., poorly stocked versus well stocked.

Areas differing by one step in two or more items of the stratum designation, e.g., P9A WM and P9B MM

Noncontrasting Conditions

10-acre minimum area

All cover types (excepting softwood versus hardwood)

One stand-size class to another one step removed, e.g., poles versus small sawtimber

One stocking class to another one step removed, e.g., medium stocked versus well stocked.

VOLUME SAMPLE

Basic Unit

The basic unit of the volume sample will be the location, consisting of two 1/5-acre circular plots, 5 chains apart. Both plots must be in the same stratum. The location will be located on the ground at the point pricked on the photo. The selection of the photo point is explained on pages 41 and 42.

The first sample plot at the location will be at the pricked point. The second sample plot will be located 5 chains away in the first cardinal direction, N, E, S, W, in that order of choice, which will place the second plot in the same stratum as the first plot. In the event that none of these directions will keep the second plot in the same stratum, then the fieldman will accept the first bearing clockwise from North which will do so.

Plot Size

Seedling-sapling trees	1/500 acre	radius 5.26 feet
Poletimber trees	1/50 acre	radius 16.65 feet
Sawtimber trees	1/5 acre	radius 52.67 feet
Salvable dead trees	1/5 acre	radius 52.67 feet
Mortality trees	1/3 acre	radius 67.98 feet

Data Recorded

Survey Sample Plots

Record plot quadrant, plot size, species, diameter class, total height and merchantability class for all trees 5.0 inches dbh and larger. Record log height and defect percent, board foot and cubic foot, for all live sawtimber trees, 11.0 inches dbh. In addition record the following data for growth sample trees:

Total height 10 years ago

Bark thickness

0 - 5-year radial growth of wood

0 - 10-year radial growth of wood

Log grades by logs for sawtimber trees.

Tree Size

Sawtimber trees - Trees 11.0 inches dbh and larger.

Pole trees - Trees 5.0 inches to but not including 11.0 inches dbh.

Seedling-sapling trees - Trees at least 1/2 foot high to but not including 5.0 inches dbh. Three size classes are recognized:

1/2 foot high to but not including 1.0 inch dbh

1.0 inch dbh to but not including 3.0 inches dbh

3.0 inches dbh to but not including 5.0 inches dbh

Sawlog

A minimum sawlog must be 16 feet long to a minimum top dib of 5 inches and must have one-third or more of its gross board foot volume in sound merchantable material. (EXCEPTION: For 1-log sawtimber trees the minimum sawlog shall be 10 feet long in judging merchantability class. See page 18 definition of merchantable sawtimber trees.)

Merchantability Classes

Merchantable

Live sound trees which meet the following specifications:

Sawtimber trees - Live sawtimber trees containing at least one 10-foot sawlog to a merchantable top dib and having one-third or more of their gross board-foot volume in sound merchantable material and which are likely to eventually contain at least a 16-foot minimum sawlog. Trees which contain a sawlog 10 feet long or longer but which are so girdled, gnarled, broomed out, or otherwise injured or deformed as to make it unlikely they will ever contain a 16-foot sawlog will not be called merchantable. (See page 20 for sawlog top definition.)

Poletimber trees - Live poletimber trees which are likely to grow into sound merchantable sawtimber trees. Pole trees with rot will not be called merchantable.

Seedling-sapling trees - Live seedling-sapling trees which are of such form and quality as to be considered potential poletimber trees. Seedling-sapling trees which do not qualify as "merchantable" are not tallied.

Sound Cull

Sawtimber trees - Live sawtimber trees having more than two-thirds of their gross board-foot volume cull providing at least one-half of this cull is the result of defects such as sweep, crook, or other sound defect. Also included are sound trees 11.0 inches dbh and larger too short to contain at least one minimum sawlog.

Poletimber trees - Live sound poletimber trees which are unlikely to grow into merchantable sawtimber trees because of serious fire and basal scars, broken tops, severe mistletoe, severe crooks, or girdling by porcupines,

will be called sound culls. Pole trees with any rot will be recorded as rotten culls.

Seedling-sapling trees - No sound cull trees recognized. Cull trees are not recorded, but will be marked with a single axe blaze.

Rotten Cull

Sawtimber trees - Live trees which have more than two-thirds of their gross board-foot volume culled, more than half of which is due to rot.

Poletimber trees - Live trees showing any evidence of rot on the main stem.

Seedling-sapling trees - No rotten cull trees recognized. Cull trees are not recorded, but will be marked with a single axe blaze.

Mortality

All trees 5.0 inches dbh and larger, standing and down, which have died within the past 5 years. Guides for estimating whether or not a tree died within the past 5 years are given on page 89, Appendix A.

(NOTE: Trees which would have been culled while alive because of shape or form should not be counted as mortality.)

Salvable Dead

All dead trees, including mortality trees, 5.0 inches dbh and larger, standing and down, which have 50 percent or more of their volume in sound wood. Salvable dead trees are tallied by two merchantability classes:

Suitable for lumber - Trees of sawtimber size which have at least one sound log not lower than grade 3²/₂ and free from spiral grain checks.

Suitable for other purposes - Salvable dead trees which are not suitable for lumber but suitable for pulp, poles, or other uses.

2/ Grade 3 - Common logs displaying either (a) numerous pin, small, or medium knots of which 80 percent are either live or will cut out red (intergrown) beneath the slab or (b) 16 dead knots (an average of 4 per face) averaging medium in size.

Breast Height

Breast height for this survey is defined as being 4-1/2 feet above mean ground level.

Merchantable Top

The point on the bole of a sawtimber tree coinciding with the minimum diameter inside bark for a merchantable sawlog. Top diameters will vary with the dbh of the tree as listed below:

<u>DBH</u> <u>(inches)</u>	<u>Top DIB</u> <u>(inches)</u>
10, 11	5
12,13,14,15	6
16,17,18	7
19,20,21	8
22,23,24,25	9
26 /	10

Tops vary by diameter classes and are precisely defined as follows:

Top dib = .3dbh / 2.0 with 10.0-inch maximum

Log Height

The number of 16-foot sawlogs in sawtimber trees to the merchantable top, rounded to the nearest log. Where the top is broken out the log height should be estimated to where the merchantable top would have been and a deduction made for cull.

CONDENSED MAP CLASSES AND SYMBOLS

Commercial Forest Land (also Productive Noncommercial)

<u>Stand-size Classes</u>	<u>Map Symbol</u>
Large sawtimber stands (21.0" dbh and larger)	9B
Small sawtimber stands (11.0" - 20.99" dbh)	9A
Poletimber stands	8
Seedling-sapling stands	7
Nonstocked and deforested stands	6
<u>Stocking Classes</u>	
Crown density (or number of trees)	
Poorly stocked 10 - 39 %	P
Medium stocked 40 - 69 %	M
Well stocked 70 + %	W
<u>Cover Type Classes</u>	
Douglas-fir	D
Western hemlock	WH
Mountain hemlock	MH
Ponderosa pine	P
Western white pine	WP
Lodgepole pine	LP
Whitebark, limber, and bristlecone pine	WLP
Western larch	L
White fir	WF
Grand fir	GF
Alpine and corkbark fir	AF
Engelmann spruce)	
Colorado blue spruce (	S
Black Hills spruce)	
Dead spruce	DS
Western redcedar	C
Aspen	A
Cottonwood	Co
Other hardwoods	OH

Noncommercial Forest Land

<u>Cover Classes</u>	Unproductive	<u>Map Symbol</u>
Aspen		NA
Chaparral		NC
Pinyon-juniper		NPJ
Other		NO

Nonforest Land

Classes

Water	W
Other nonforest	NF

Examples of Stratum Map Symbols

The order of recording the various components of a stratum description will be: Cover type, Stand-size class, Crown density, all trees and sawtimber trees.

P9A WM	Ponderosa pine type, small sawtimber stand, well stocked by all crowns, medium stocked by sawtimber crowns
D9B PP	Douglas-fir type, large sawtimber stand, poorly stocked by all crowns, poorly stocked by sawtimber crowns
D8 M	Douglas-fir type, poletimber stand, medium stocked by all crowns
LP7 W	Lodgepole pine type, seedling-sapling stand, well stocked by all crowns or stems
P6	Ponderosa pine type, nonstocked or deforested
NPJ	Unproductive noncommercial forested land, pinyon-juniper type
NC	Unproductive noncommercial, chaparral type

AERIAL PHOTO PREPARATION

Photo Indexes

Aerial photography may include projects flown for the Forest Service, Soil Conservation Service, Commodity Stabilization Service, and occasionally others. Complete coverage by photo index sheets will be obtained. On these index sheets large areas of nonforest land will be blocked out as nonforest zone and eliminated from any sampling. On the area retained as forest zone the sampling strips will be laid out. Those flight lines of photographs whose centers fall closest to the sample strips will then be ordered and will be used as the sample strips.

Photo Orders

List the photos needed per strip by strip number, county, project symbol, roll and photo numbers. This initial listing will serve as a guide in sorting and filing the photos when they are received. The photo orders should include:

1. Agency, project, and contract number
2. All photos ordered should be identified by project symbol, roll number, inclusive print numbers, and total prints per roll and per order.

Preparation of Contact Prints

On receipt of a photo shipment the print numbers should be checked against a copy of the order. All photos should then be trimmed, and sorted by counties within strips and county names, strip numbers, and the Forest Survey identification stamped on the back of each photo.

Filing contact prints - Contact prints will be filed by strips within sampling units. Counties will be segregated within each strip. The northernmost photos should be filed first in each strip with photo numbers in sequence either in ascending or descending order.

AERIAL PHOTO PREPARATION

National Forest Unit

A national forest unit will consist of all 15-minute quadrangles entirely or partly included within the forest boundary. All area within the forest boundary will be considered the "mapping project" and the remaining area of each quadrangle will be termed "outside." Areas entirely separated from the national-forest units will be considered strip sample areas.

Unit Quadrangle Index Map

For each sampling unit a 1/4-inch to the mile, or larger size, quadrangle index map will be prepared, using the forest map as a base. On this map enter the boundaries of the 15-minute quadrangles with the numbers as assigned by the Division of Engineering (such as 44 NE) and the photo project symbol (such as DKK). Areas outside the mapping project should be shaded lightly with colored pencil.

Photo Indexes

Prepare photo indexes as follows:

1. Mark quad boundary in red pencil and boundary of area ~~to be mapped~~ in orange pencil.
2. Enter quad number (from index map) in pencil near title block, and enter names of some streams or other landmarks in red ink.
3. Flight lines will be numbered individually within quads from left to right. No. 1 will be the first flight line on the left with one-half or more of its width within the quad. Adjoining flight lines should be numbered in one quad only, and all flight lines needed in the sampling unit should be included.
4. Photostatic copies of the indexes should be prepared and filed in the folder with the contact prints for each quad. Originals may be filed by photo project or by county.

Photo Orders

Within the sampling unit, list photos needed per quadrangle, by flight line, project symbol, roll and photo numbers. This initial listing can then be used in sorting and filing the contact prints when received. The photo orders should include:

1. Project and contract number and agency
2. Project symbol, roll number, inclusive print numbers, and total prints per roll and per order.

First and last print ordered from each flight line should be checked in red on photo index. When ordering photos from more than one project order one or two photos from each project which overlap the end photos of the adjacent project.

Preparation of Contact Prints

On receipt of photo shipment print numbers should be checked against copy of the order. Preparation will normally include trimming, entering sampling points, marking photos outside the mapping area, outlining effective areas, and filing by 15-minute quad and flight line.

Trimming - Trim all photos to 9 inches by 9 inches, being careful not to cut off identification or fiducial points. Stamp all photos on back with Station stamp when trimming is complete.

Sampling points - After trimming, the sampling points, consisting of open-centered crosses will be printed on the photos by multilith process. Photos should be fed into machine with identification numbers leading. This will place the sampling points for each photo as shown on the sample photograph on page 24.

Sorting by 15-minute quadrangle units - The purpose of this final sort is to group the photos into the geographical units by which the base maps are prepared and by which the transfer of data from photos to base maps will be made. The photos will go to the interpreters, to the field crews, and to the Division of Engineering for transfer by these 15-minute quadrangle units.

After the sampling points are entered, the photos should be sorted by quad and flight line as shown on the initial listing by quadrangles. Northernmost photos should be first in the flight with photo numbers in either ascending or descending order. Numerical sequence may be broken where flight line includes photos from more than one roll, or where photos over nonforest areas, such as farmland, were not ordered. Enter flight line number and stamp quadrangle number on the back of each photo.

When two or more sampling units are included in a single quad, flight lines will be separated by the different sampling units but all photos will be retained in the same 15-minute quadrangle unit. This break should follow the unit boundary line as indicated on the photo index.

Boundary of mapping project - The boundary of the mapping project will be transferred to the photos from the forest map and the photo index sheets using colored pencil. Mark the words "Outside" or the name of the adjacent survey unit beyond this boundary. Where base maps are so generalized that locating an exact boundary along photo image points is difficult, indicate the approximate boundary, but locate it on the photo approximately one-half mile beyond the limits of the survey unit. Subsequent type delineation will be carried to this approximate boundary. When types are projected to a base map the narrow zone of typing beyond the actual unit boundary may be ignored.

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Mapping unit boundaries put on the photos as above will also serve as effective area boundaries in those cases where they mark the line between areas inside or outside of the mapping project. Where the boundaries on the photo represent the break between two immediately adjacent forests, the effective area boundaries will be as described later.

At this stage also transfer the 15-minute quadrangle boundaries from the photo index sheets to the contact prints. Only those boundaries which are at right angles to the flight lines need be transferred. These boundaries will serve as one side of the effective area for the photos on which they are drawn and will also serve as the match line for tying the mapping across quadrangle boundaries.

Photos outside coop areas - Photos completely outside the cooperative project will be marked with an "O" under the photo number, in orange pencil. Effective areas will not be entered on "outside" photos and no mapping will be done on these photos. However, sampling points will be interpreted and tallied on these photos.

Noneffective photos - Photos which duplicate coverage, such as at the ends of overlapping strips, will be marked as noneffective by entering a cross through the photo numbers in red pencil. Normally duplicating coverage will not be ordered but checking at this time should indicate any duplication.

In level areas it may be possible to type map on alternate photos, in which case every other photo will be marked as noneffective. All noneffective photos will be left in the flight line for use as stereo coverage.

Filing photos - Pocket-type file folders, labeled by quadrangle number, will be prepared for each quadrangle included in the national-forest units.

On the front of each folder list the following:

<u>Flight Line</u>	<u>Project Symbol</u>	<u>Roll Number</u>	<u>Inclusive Photo Nos.</u> (north to south)
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Upon completion of this step the photos in 15-minute quadrangle units will be turned over to the photo interpreters.

Outlining Effective Areas

Ordinarily outlining effective areas is a task which will be carried out by the Division of Engineering in Denver. For photos ordered from agencies other than the Forest Service for delivery to the Forest Survey unit at Ogden this task may be done there.

The objective is to outline an approximate rectangle in the central portion of each effective photo. This central area is called the "effective area." The boundaries of an effective area on one photo should pass through image points common to the effective area boundary on the next adjacent photo, either in line of flight, or in an adjacent flight. Types will be delineated only within effective areas. This procedure insures that all types within a survey unit are delineated, and that proper tie-ins of type lines are made between all adjoining photos. The procedure will also expedite the subsequent transfer of type information to base maps. Thus delineations of types will be confined to photo areas where distortion due to relief, camera tilt, and lens aberration is at a minimum.

Outlining of effective areas is an important step, and should be done carefully. However, it is routine in nature. This step is good introductory training for inexperienced personnel in use of photos. This work load may be staggered between other jobs at a rate which keeps it safely in advance of type delineation. The interpreting unit supervisor should

supervise this work closely, especially when photo coverage involves many skewed flight lines and irregular or broken flights.

Procedure in Line of Flight - Endlap

Step 1. Within the mapping project select the first effective photo in a flight line. This will usually be the first photo with photo center falling within the working circle or survey unit. And if good map information is available mark the survey unit boundary on that photo in red grease pencil. Mark the words "OUTSIDE UNIT," or the name of the adjacent survey unit in blue grease pencil beyond this boundary. If base maps are so generalized, or locating an exact boundary along photo image points is difficult, indicate the approximate boundary. Locate this approximate boundary far enough towards the edge of the photo so that it may be assumed to be a reasonable distance (1/2 to 1 mile) beyond the limits of the survey unit. Subsequent type delineation will be carried to this approximate boundary. When types are projected to a base map the narrow zone of types beyond the actual unit boundary may be ignored.

Step 2. Select the adjacent effective photos in line of flight and match image points of effective photo No. 1 and effective photo No. 2 approximately by overlapping photo No. 1 over photo No. 2. Then draw a straight line in green ink or green crayon pencil (Dixon's Best, May Green, No. 356) on photo No. 1 in such a way that it approximately bisects the field of overlap, and is approximately perpendicular to the line of flight.

Step 3. Indicate the location of the line plotted on photo No. 1 on the second photo. Accomplish this by noting two image points through which the line on photo No. 1 passes, spotting those corresponding image points on photo No. 2, and drawing a corresponding line on photo No. 2 through

those points. On photos of gentle terrain, or flat topography, the only criterion for selecting corresponding image points is that they be separated by several inches along the bisecting line. However, on photos of rough terrain it is necessary also that image points be selected which lie at approximately the highest points in the elevational levels crossed by the line plotted on photo No. 1. Stereo fusion of the field of overlap facilitates this procedure.

If this procedure is not followed there is a chance for an appreciable acreage covered by photo detail being excluded from effective areas of both photos in the zone of overlap. If selected image points are at high points in the transect of topography crossed by line No. 1 there will be no exclusion of photo detail. Actually, a slight duplication of detail within effective areas will occur in detail of the lower elevations. Careful plotting of boundaries is required to avoid exclusion or duplication of photo detail in all matching of effective areas. This follows from the nature of displacement of photo images due to relief, for images of objects higher than the datum plane are displaced outward and images of objects lower than the datum plane are displaced inward from their true relative horizontal positions from photo centers. For our purpose it is satisfactory to accept some slight duplication of images within effective areas. By matching effective area boundaries to high points the time-consuming task of plotting boundaries between every break in topography, at different angles, is avoided.

Step 4. Indicate in the endlap areas the number of the adjoining photos using black or green ink.

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Step 5. Repeat procedure described in steps 2 and 3 above using photo overlaps between photo No. 2 and photo No. 3, and for all subsequent overlaps of effective photos in line of flight.

Step 6. When the last effective photo in a flight line in a quadrangle is reached, transfer the boundary of the quadrangle from the photo index sheet. This will serve as the effective area boundary for the photo and the match line for tying between quads.

Procedure Between Lines of Flight - Sidelap

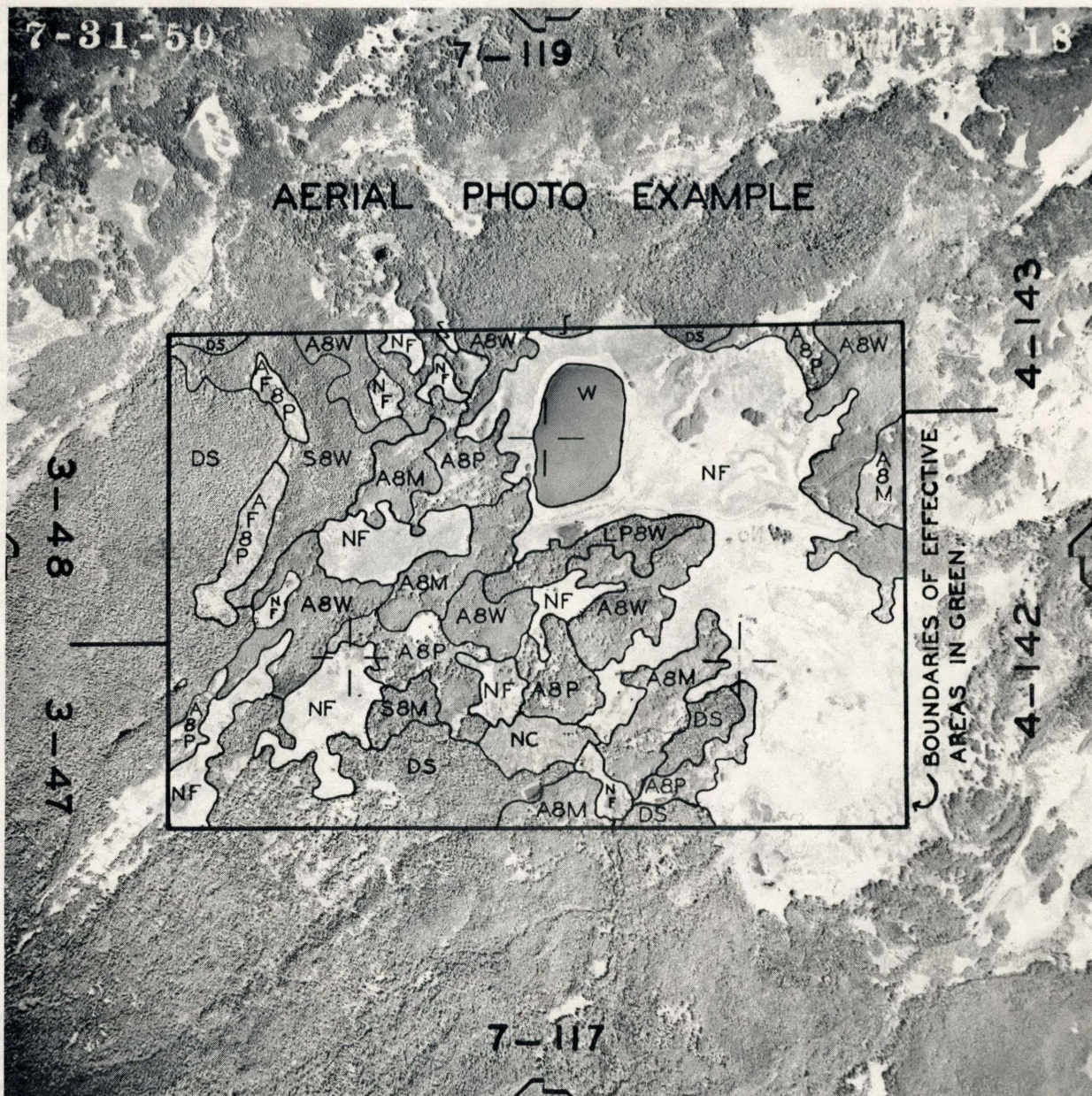
Step 1. Place stacked pictures of two adjacent flight lines side by side with the overlap areas next to one another.

Step 2. Lap sideways the first picture of each flight line. Draw a line in green ink on the top picture, bisecting approximately the zone of overlap. Draw this line only until it connects with the endlap line, or terminate it with a right angle projection into the sidelap area if it doesn't reach the endlap line.

Step 3. Transfer the sidelap line to the photo underneath visually.

Stereo fusion of images appearing in different flight lines is usually difficult or impossible. Therefore, the transfer procedure may often be most readily accomplished by holding the photos in position of overlap with one hand until the transfer is completed. If the edge of the overlapping photo is tipped up and down several times the eye can note where corresponding positions occur on the underlapping photo and the free hand may be used to mark these positions.

Step 4. Indicate in the sidelap areas the numbers of the adjacent photos, using black or green ink.



QUAD No. 44 SE

Flt. 6

No. 142

→ R.P. - 24" D.F.

N 74° E 4-1/2 chs. to Plot No. 1

Scale 1:18,000

PHOTO INTERPRETATION

The photo delineation of forest types, stand-size classes, and density classes is a combination field and office job. In the interests of economy, the objective should be to get the most value from available photography through a maximum of office interpretation and a minimum of field work.

The determination of forest cover types from aerial photographs depends for the most part on tone and texture, shape of the crown, topographic location of the cover type, and the interpreter's knowledge of the area being examined. Photographic features for a given timber type may vary considerably because of the influence of such factors as season of the year, time of day, type of film and filter, exposure, development and printing, and stand density. The forest mapper must therefore be able to associate a particular tone, texture, shape of crown, and topographic location of an area being examined with a particular forest cover type.

PRELIMINARY RECONNAISSANCE

When possible, a preliminary field reconnaissance of the area should be made before interpretation is begun. During the reconnaissance trip, the interpreter should expand his general knowledge of the forest pattern of the area to be mapped, as well as make detailed comparisons between images on photos and the objects on the ground. This reconnaissance should consist of rapid coverage of main travel routes with maps and photos at hand. Make notes directly on the photos to indicate some examples of typical and exceptional forest classes. A few spot location notes on stand heights, dbh classes, and age classes will also be useful. Temporarily record these notes on face of photo in red pencil such as Dixon's

Best Lake Red No. 321-1/2, and also record them on the back of the photo opposite spotted location for permanent reference. (If a photo is held with its face toward the light it is easy to spot the corresponding location on the back of the photo for any data appearing on the face of the photo.) Comparison of representative stands with the examples shown for them on the stereograms should also be made if available.

GENERAL CHARACTERISTICS OF PHOTOGRAPHS

Photographic images are generally identified on the basis of five elements:

1. Shape and size
2. Color and tone
3. Texture
4. Image pattern
5. Field experience with images

Objects may be identified by one of these elements but usually the interpreter must use all or several to make his identification. The stereoscope should be used at all times during the interpretive process.

Shape and Size

Shape refers to the general form, silhouette, or outline of an object. Tree crowns appear round, ovoid, or pointed when viewed from above, but appear elliptical when viewed obliquely on the margin of the photo. Shapes and shadows are an excellent clue to tree species. For example, spruce and alpine fir have slender, pointed shadows; aspen has a rounded shadow. However, it should be remembered that shadows can be grossly exaggerated by slope, either by elongating the shadow so it appears long and slender, or by shortening it and making it appear short and stubby depending upon whether the shadow falls either downhill or uphill.

Size relates to the surface or volume dimensions of an object. Trees appear tall or short, big or small, depending on their size. While the visual photographic shape and size of an object is related to its actual size and shape, this relationship is modified by scale and distortion or displacement. Scale changes within a single photo are seldom perceptible, except in those cases where extreme elevational changes of 2,000 - 3,000 feet occur. However, elevation can frequently change 3,000 - 4,000 feet over a long flight line of photos. In this case, changes are cumulative, and a gradual scale change takes place. An elevational change of 3,000 feet would produce a 30 percent difference in the apparent height of trees of equal size viewed at the extremes of the elevation on photos of 1:20,000 scale.

Objects viewed on the margin of the photo are seen more or less from a side view, rather than the top view near the photo center. Trees seen on the margin may seem to be taller than those near the center because of this difference in view. The interpreter should be careful not to let this difference influence his ideas of stand size.

Some objects are not large enough to be seen on photos with the magnification of the ordinary stereoscope. As a general rule, trees with a crown diameter of less than 3 feet cannot be seen on photos of 1:20,000 scale. However, lineal objects of smaller size such as railroad tracks, white lines on a black highway, and down snags may occasionally be seen. This should not be assumed to be a scale change. For some reason, very distinct lineal objects may sometimes be seen where other objects, such as trees of small diameter, are not visible.

Since objects less than 3 feet in diameter are not visible at a scale of 1:20,000 it is usually assumed that the portion of the tree crown less than 3 feet in diameter is not visible for height measurement. Trees whose total crown width is less than 3 feet may not be seen at all. Thus in very small, poorly stocked seedling stands, many of the trees may not be visible.

Height perception of objects less than 10 feet high is often difficult on photos of 1:20,000 scale, even when the crowns are large enough to be seen. Thus, brush may appear as grass except for a coarser texture. In the case of relatively short trees, shadows are the best indicator of height. Sometimes shadows of objects can be seen when the objects themselves cannot be distinguished.

Color and Tone of Images

Photographs are in black and white. Between these extremes are varying shades or tones of gray, depending upon the degree to which objects reflect light. Dark objects reflect little light and therefore photograph dark. Light objects reflect considerable light and therefore photograph light in color. Consequently the same difference in foliage colors that aid species identification on the ground are reflected as tonal difference on photographs. For example, the light green of aspen, the medium yellow-green of lodgepole pine, and the very dark green of spruce are represented on photos by tones of gray varying from the very light gray of aspen to the very dark gray of spruce. During the late fall, when aspen foliage is yellow, aspen has a very light tone, almost the same as grass.

Tone is influenced by season, time of day, shadow, development of print, position of the object in relation to the photo center, slope, and site. Season and time of day affect the quantity and direction of reflected light.

and the amount of shadow. Timber stands photographed at noon have very little shadow and have a correspondingly lighter tone. Timber stands photographed either before or after noon have longer shadows and timber stands will appear to have a darker tone.

Most aerial photos are contact prints. The skill of the printer and type of paper will determine the over-all tone of the photos. Overexposed prints have tones in the darker range, while underexposed prints appear much lighter. These unusual prints should be compared with average tone of other photos in the flight so that the odd tones do not influence the interpretation impressions of species or density.

Objects on the extreme margin of the photo tend to be darker because of the poorer light-gathering qualities of the lens in that area. However, this difference is usually not apparent within the effective area.

South slopes usually appear lighter than north slopes. This is frequently due to less vegetation on the south slope. The north slope usually shows greater amounts of shadow and also reflects less light than a south slope. Moist sites usually photograph darker than dry sites. Thus a swampy meadow seems darker than dry grassland. This is due to the more lush, darker green vegetation in the moist site and frequently some surface water. Water itself usually photographs very dark or black, except in a particular situation when the sun is reflected off the body of water at just the right angle with respect to the camera. In this case water photographs white.

Texture

Texture is a term used to describe the apparent degree of fineness or coarseness of features seen on the photo. On photos of 1:20,000 scale, texture is used to describe the appearance of stands of timber since

individual tree crowns are too small to display visible textures. Thus the texture of a timber stand is a product of the size, shape, shadow, and arrangement of the crowns within the stand. The texture of timber stands is analogous to a sheet of sandpaper. A piece of sandpaper with small-sized grit would be finer textured (and smoother to the touch) than another piece of sandpaper with very large pieces of grit. A dense, small-crowned stand of lodgepole pine would appear to have a finer texture than a stand of mature, large-crowned uneven-storied spruce.

Size and arrangement of the crowns within a timber stand affect texture the most. A very dense stand of poles would have a finer texture than an open-grown pole stand. Thus, as the size of the individual crown and the distance between crowns increases, the texture of a stand tends to become more coarse. Shadows often obscure smaller crowns and give the impression that the larger crowns are more widely spaced. Stands viewed obliquely appear coarser than stands viewed from above.

Comparative textures of some objects:

Very fine - water, grass pastures, cultivated fields

Fine - very dense stands of brush, aspen, or conifer reproduction

Medium - mixed stands of poles and saplings, small crowned sawtimber

Coarse - mature sawtimber of medium density

Very coarse - overmature timber with or without an understory of poles and small sawtimber, or partially cut stands

Image Pattern

Pattern regularity often indicates the efforts of man. Cutting lines, right-of-way clearings, plantations, and fencelines are examples.

Field Experience With Images

The interpreter will usually have no difficulty identifying species and timber stands on the ground because these objects are viewed from a familiar angle. Identification on photos is more difficult because objects are seen from an unfamiliar vantage point somewhere above these objects. Thus the interpreter must translate what he sees on the photo into what he would see if he were on the ground at the point in question. To do this he must draw on his general forestry training, his general knowledge of the area, and the correlations of species with site, slope, and topographic conditions within the area to be typed.

CHARACTERISTICS USEFUL FOR MAPPING

Some characteristics which will aid in the classification of forest land are discussed in the following paragraphs:

Stand-Size Class

Stand-size is probably the most important single item to be seen on photos, since it is most directly related to the volume of the stand. Height and crown diameter are the two factors visible on photos that determine stand-size classification. Four classifications are recognized: seedling-sapling, pole, small sawtimber (11.0" - 20.99"), and large sawtimber (21.0" and larger). One of the more readily discernible features visible on photos is stand-size differences.

Sawtimber - Height is the most obvious clue. The taller the stand, particularly in relation to other adjacent stands, the greater the probability that the stand is sawtimber. Crown size is generally related to DBH: The larger the crown, the larger the DBH. Generally, larger crowns coupled with increased height indicate sawtimber. Once a stand is determined to be sawtimber, crown size is the best indicator as to whether or not the

stand is small (9A) or large (9B) sawtimber. Extreme care should be taken in determining stand size between lodgepole pine poles and sawtimber. In this case, there may be very little height or crown size difference. Generally a coarser texture is associated with sawtimber stands.

Poletimber - Height shorter than sawtimber but greater than seedling-sapling stands. Crown size is smaller than sawtimber but larger than seedling-sapling stands. Texture generally finer than sawtimber for a given species but coarser than seedling-sapling stands.

Seedlings and saplings - Height is shortest, crown size the smallest, texture is the finest. Differentiation between poles and seedling-sapling stands will be most often based on height and texture, since little or no difference may be visible in crown size. Some seedling-sapling stands may not resolve on 1:20,000 photos.

Density

In using density guides to determine stand stocking, it is necessary to compare the number of crowns on a given area with the number of blackened squares on the guide. Although a stand may appear very dense and black, much of the denseness may be caused by black shadows filling the space between crowns. Therefore the interpreter must look at the visible crowns and not be too greatly influenced by the dark shadows between the trees. The black squares on the density guide represent only crowns and do not include crown shadow. Photos taken at high noon will have little shadow and stands may appear to be less dense than those seen on photos taken either earlier or later in the day with a correspondingly greater amount of shadow. In unevenaged stands, the taller trees may partially or totally obscure the smaller trees with their shadows. The photo interpreter should

attempt to look through or into these shadows to see if other crowns do exist below these larger trees.

Species Identification

Species identification is perhaps the most difficult part of the photo interpretation job. The following guide to species identification is based on the size, shape, color and texture characteristics peculiar to a certain species.

Aspen - Crowns generally rounded and fluffy, never sharply pointed as in spruce or alpine fir. Color usually lighter in tone than adjacent conifers. (See stereogram No. 18, area 3) Stands photographed after leaves have turned color appear much lighter than surrounding conifers. (See stereogram No. 11, areas 1 and 2) Stands photographed after leaves have fallen off (note date of photo) may appear to be extremely light, possibly the same color as surrounding grass. However, close inspection of these areas may reveal hazy or fuzzy outlines above the ground level as opposed to the flat white appearance of grass. (See stereogram No. 6, area 3, and No. 17, areas 3 and 4) Texture of aspen stands varies from fine (seedling-sapling) to medium (large poles or sawtimber). Aspen almost never has the coarse, ragged texture found in conifer sawtimber. Aspen grows either as a pure stand or mixed with conifers. In mixed stands, the conifers appear much darker. In pure stands, aspen typically appears as a soft, fluffy, expanding cloud. Individual crowns generally cannot be recognized and the surface of the stand canopy is more or less smooth or gently undulating. Aspen frequently grow so close together that it is difficult to see into the stand as can often be done in the more widely spaced conifer stands.

Lodgepole pine - Crowns generally small and compact, individual crowns clearly distinct, except in very small, dense seedling-sapling stands.

(See stereogram No. 2, areas 1 and 2) Crowns do not appear sharply pointed as in spruce. (See stereogram No. 17, areas 1 and 2, and No. 5, areas 1 and 3) Color generally lighter than surrounding conifers; however, since color is relative to time of day, printing of photo, and other factors, it may vary from photo to photo. (See stereograms Nos. 1, 2, and 5) Texture is fine to medium. Seedling-sapling and pole stands are typically fine textured. (See stereogram No. 16) Open-grown stands and sawtimber stands tend to be about medium textured. (See stereograms Nos. 6 and 1) Lodgepole pine almost never appears to have the extremely coarse texture found in spruce stands. (See stereogram No. 17, areas 1 and 2) Since lodgepole grows in both pure and mixed stands, these characteristics are influenced by other species in the mixed stands. (See stereogram No. 1, area 3) Where lodgepole pine grows in fairly dense stands, the canopy appears as a series of small gray, sometimes shiny, dots. (See stereogram No. 1, area 3; and stereogram No. 5, areas 1 and 2)

Spruce - Crown definitely pointed, sharp in appearance. Individual crowns or groups of crowns clearly distinct. Crown shape particularly obvious when seen near edge of photo, where the crown is viewed more from the side than from the top. In this position, the spruce crown appears to be a long, tapering candle. (See stereogram No. 17, area 2) Color of the crown varies from medium gray to dark gray. Frequent white or dark black holes can be seen in the general canopy. (See stereogram No. 17, area 2) Texture varies from medium (stereogram No. 3, area 2) to very coarse (stereogram No. 8, area 1 and stereogram No. 17, area 2) Mature spruce sawtimber stands generally

appear to be the most ragged and coarse textured stands seen on the photos. Shadows of spruce have the same characteristics as the crown: long, slender, and pointed. These shadows are good indicators and can be readily seen along the edge of stands. However, the shadow may exaggerate the crown shape or size, particularly if the shadow falls either uphill or downhill from the tree. Where the shadow falls on the side slope or on level ground, it is a good indicator of crown shape.

Dead spruce - Crowns have the same characteristics as live spruce: long, sharp, and pointed. Color is the most important indicator of dead spruce. Dead crowns appear definitely lighter. (See stereogram No. 8, area 1) When viewed on the edge of the photo, the crown appears as a long white candle. Shadows of dead spruce have the same shape and color as live spruce shadows. Generally, these trees have not been dead long enough to drop their branches. (See stereogram No. 8, ground photo) As a result, the crown retains the same general shape as that of live trees. Texture usually appears to be very coarse, with frequent black holes. This gives the stand a stark, black and white appearance not seen in other stands. (See stereogram No. 8)

Douglas-fir - Crown generally rounded and compact, usually larger in size than lodgepole pine crowns. Individual crowns clearly distinct (stereogram No. 13, area 1). Seldom sharply pointed. Color generally the same or slightly darker than lodgepole pine. Texture medium to coarse, but generally not as coarse as spruce of the same stand size.

Alpine fir - Crowns most pointed of all conifers, shadows usually show the characteristic long, slim, sharply pointed crown shape, more so than spruce. Color and texture very similar to spruce.

Pinyon-juniper - Crowns generally small, round, and dark gray in color.

These stands are short and characteristically open grown. Texture medium to fine.

INTERPRETATION PROCEDURE

Generally the best approach in delineating forest strata is to work from the obvious to the difficult. General procedure should be as follows:

1. Separate the nonforest land from the forest land and label the nonforest areas with proper symbols.
2. Separate the forest land into commercial and noncommercial areas. Label the noncommercial strata.
3. Separate hardwoods from conifers down to the minimum stratum areas.
4. Break the remaining commercial forest area into appropriate strata.

Start with stand-size differences and then further refine the strata by delineating differences in crown density within a given stand-size class. Proceed from the most obvious to the more difficult. Some caution should be used in this step because some differences plainly visible on the photo may not need to be delineated under our mapping system. For example, a definite and obvious stand height difference may be visible on the photo. Both stands are composed of the same species and have the same crown density. But one is a 30-foot pole stand and the other a 50-foot pole stand. In this case the two stands would be mapped as a single stratum because they both fall into the same stand-size class.

Any type smaller than the minimum area of 5 or 10 acres will be included in the nearest related adjoining type. Hardwoods will be included with hardwoods and conifers with conifers, regardless of stand size or density. Otherwise relationships will be based on stand-size class, density, and

specie, in that order. For example, a 4-acre area of conifer sawtimber located between a conifer pole stand and a conifer seedling-sapling stand would be too small to be delineated as a type itself. Therefore the sawtimber stand would be included with the pole stand, since sawtimber is more closely related to a pole stand than it is to a seedling-sapling stand.

In all cases where small types are included with adjacent types, consider the effect of such inclusions upon the composition of the resulting area. For example, a number of small meadows scattered throughout a large area of well-stocked timber may lower the stocking from well to medium.

Ignore type stringers less than 120 feet in width. In applying either minimum width or minimum acreage controls to mapping attempt to delineate the natural shape as well as size of areas. With aerial photos many type boundaries are relatively easy to outline for production of a map which has the natural character and pattern of the country. It is poor practice to produce, by careless mapping, type boundaries that are mainly geometric figures, e.g., rectangles or circles.

Types should be outlined within the effective areas only. Use black Weber's ink on the face of the photo for both type line and symbols. Be sure that all areas are labeled, leaving no blanks and no cases of two or more differing labels for the same area as delineated on the photo. Check each photo for these items as it is completed.

Orient all symbols to read with the same edge of the photos up, generally the east edge. Show map symbols in the following sequence: Forest type, Stand-size class, Density, e.g., D9A WM, LP8 W, S9A PP, NPJ.

If necessary to make corrections on the mapped photos, use moist absorbent cotton to remove the Weber's ink, and art gum eraser only to

remove pencil marks. Rub lightly in all cases so as to not scratch or remove the emulsion. If the photos are difficult to ink, wipe the emulsion side with carbon tetrachloride to clean the surface. Be careful not to obliterate the effective area lines.

Use the photo interpretation aids provided for estimating minimum areas and density classes. These are:

Crown Density Scale - Percent Crown Cover

Forest Survey, Central States Forest Experiment Station

Timber Survey Aid No. 1 - Units of Measurement at 1:20,000 Scale

Pacific Northwest Forest and Range Experiment Station

Forest Survey Stereograms

Forest Survey, Intermountain Forest and Range Experiment Station

Tie type lines and designations across effective area boundaries between photos as you go along. Check each flight line for these items as it is completed.

Field Checks

The interpreter should make special note of areas where he is doubtful of his classification, and special effort should be made to check the interpretation in these areas. Where possible it is desirable for the interpreter to make occasional trips into the area during the course of his interpretation as a check on his work in progress. Frequent field checks should be made during the beginning of the job. In this way, as well as during the preliminary reconnaissance, the interpreter will acquire a mental backlog of ties between photo and field conditions. As this backlog increases the field checks can be reduced and largely limited to those types that are the most difficult to recognize and areas where the interpreter has the most difficulty in making his identification. Field checks should never be completely eliminated.

Mapping Procedure

The objective is to map the entire area of each sampling unit on the photos including necessary field checks prior to beginning field plot work in the unit. All land within the effective area of photos falling within the sampling unit boundary will be delineated and classified according to the classifications, symbols, and standards set forth on pages 10-16.

However, in order to insure that the necessary information is available to allocate field plots and to begin actual field work even though the unit may not yet be completely mapped, the first step in the actual photo mapping phase will be the delineation and classification of the stratum immediately surrounding each photo sample point. Exactly the same standards are to be used as for the entire mapped area, since these areas will be an integral part of the completed map. The interpreters should take care that no more or less refinement be used around the sampling points than in any other portion of the photo. As each photo sampling point is delineated and classified it should be recorded on the Photo Sampling Point Record. When all points in a sampling unit have been so recorded the interpreters should then go ahead with the 100 percent map by mapping the remaining area on the photos.

Expected Accomplishments

Using every photo, there will be approximately 1,200 acres of land represented at a scale of 1:20,000 by the effective area of each photo. Each photo interpreter will be expected to complete an average of 10 such photos per day, or approximately 12,000 acres gross land area per day. When classifying only the sample points an interpreter should complete 100 or more photos per day.

Progress Report

Each interpreter or group of interpreters working on the same sampling unit should maintain currently a progress map on a quad index sheet showing 15-minute quadrangle boundaries. Progress of photo interpretation should be posted to this map at not less than weekly intervals.

PREPARATION FOR FIELD SAMPLING

PRELIMINARY DETERMINATION OF AREA

The preliminary determination of area is for the purpose of allocating the volume sample plots by strata and distributing them geographically. This determination of area will be made from tick marks or dots on the sample strip photos. The preliminary area figures obtained thus will be adjusted according to information obtained from the field check to arrive at final area figures.

DETERMINATION OF NUMBER OF VOLUME SAMPLE PLOTS

The actual determination of the number of volume sample plots for a unit will be made at the completion of the photo interpretation phase for that unit, taking into account the relative size and importance of the various strata as determined from the preliminary estimate of area.

The calculation of number of sample plots needed will be on the basis of Forest Survey required error limits and variation coefficients as obtained from past experience.

SELECTION OF SAMPLE LOCATIONS

When the number of plots to be taken in a given stratum is determined, the listing of sampling points by photo and stratum is used to find which sampling point listed for that stratum will be the one used for the actual field sample location.

For example, assume that 150 sample points are listed for stratum LP9AW, and it has been determined that 10 field samples are needed in this stratum. Then 150 divided by 10, or 15 is the sampling interval.

Draw a random number between 1 and 15, say 8. Beginning with the first Photo Sampling Point Record, and counting only the LP9A-W entries, reading

from right to left and down the sheet, the 8th, 23rd, 38th, etc. sampling points are marked as the points to be used for the field sample. Where at least twice the required number of points are available in one column of the list of number of sampling points by stratum, the selection of ground locations may be made from this one column.

Prepare a Sample Location List as shown on page 43 showing location number, stratum, quadrangle number, photo symbol, roll and number, sampling point number, township, range, and section number. The numbers of the sample locations can be assigned by starting with the first tick mark selected for a field location on the first of the Photo Sampling Point Records and proceeding from there. Township, range, and section number will be added after the field locations have been transferred from the photos to a forest map. The original of this list will be kept in the office files and copies sent to the field parties as needed.

From the information on quadrangle number, roll number, and photo number given on the Sample Location List select the photographs having the desired sampling point.

Prick a small hole through the photo at the exact center of the proper sampling point. Circle this hole on the back of the photo with ink, and write the stratum designation and the sample location number. Use a fine pointed needle and make a very small pinhole.

Using the photograph having a field location on it and the line index map, spot the location on a forest map and number it. This map will be labeled "Sample Location Map - Such and Such Sampling Unit."

The original copy of this map will be kept in the office files and copies sent to the various field parties as needed.

PREPARATION FOR FIELD SAMPLING

PRELIMINARY DETERMINATION OF AREA

The preliminary determination of area from the photos is for the purpose of allocating the volume sample plots by strata and distributing them geographically. This determination of area is made by means of the three tick marks or sampling points printed on each photo.

After photo interpretation is completed a listing of the stratum at each tick mark within the sample unit should be made. This listing will be made on the Photo Sampling Point Record (see sample). (NOTE: In using this form, use only the last density symbol (sawtimber trees) for sawtimber stands as this will be the basis for sample location distribution. Thus LP9AWP, LP9AMP, and LP9APP will be all called LP9AP.) For each photo, tally the stratum designation at each sampling point, in the column headed with the corresponding sampling point number. A sampling point falling outside the sampling area and therefore having no map symbol will be tallied as a dash. The sampling points on the photos are considered to be numbered thus:

1
2 3

The data from the Photo Sampling Point Record will then be summarized as shown below to show the total number of sampling points tallied in each map stratum and the proportion falling in each class:

Stratum	Photo Sampling Point			Total	Proportion
	1	2	3		
LP9A-W	530	620	401	1,551	.2408
LP8-M	140	249	99	488	.0758
etc.	etc.	etc.	etc.	etc.	etc.
Total	2,142	2,148	2,150	6,440	1.0000

Colorado Supplement

Dead spruce will be sampled as a single stratum across all forests, disregarding stand-size class, and density. The maximum sampling error will be 10 percent on a cubic-foot basis with an estimated variation coefficient of 50.

The above estimated variation coefficients will be revised as data become available. The combined sampling error goals and variation coefficients are expected to give approximately 280 - 300 volume sample locations per forest, with an expected sampling accuracy of 5 percent per forest.

E
X
A
M
P
L
E

SAMPLE PLOT INST

White River N. F. Sampling Unit

Loc.		Stratum		Quad.		Sample				
No.	PI	Field	No.	Symbol	Roll	No.	point	No.	Twp.	Rge. Sec.
1	LP9AW		44 NE	DIT	6	41	2	2S	95W	7
2	LP9AP					42	3	2S	95W	19
3	LP8W					44	3	3S	95W	29
4	LP7P					47	1	5S	95W	18
5	S9AM		44 SE		8	124	2	9S	87W	12

Etc.

FIELD SAMPLING

CHECK OF PHOTO INTERPRETATION

In addition to the checking done by the photo interpreters of their own work, the field crews will also check the photo interpretation. Besides measuring the volume plots, they will be expected to check the photo interpretation of all areas traveled through or visible from routes of travel to and from the volume sample locations. When selecting photos for a sample location to be visited, the fieldmen should also carry along photos covering additional areas which they will be able to see during the day and should check the interpretation on these photos. Where possible different routes of travel to and from the sample locations should be used in order to see as much as possible of the area.

Items to be watched for are changes which have taken place since the photos were taken, and actual errors in interpretation. Normally the errors of interpretation will be in type and stand-size class. In all cases of doubt as to the proper classification the benefit of the doubt will be given to the original interpretation and no changes made. Unless changes have taken place since photography or there are very obvious errors, changes in density classes will not be made by the field crews. A better estimate of crown density can usually be made on the photos than on the ground. Changes will be made with red crayon pencil such as Dixon's Best Lake Red, No. 321-1/2.

Changes in stratum designation as a result of sample plot measurements will not be made unless a careful examination of the photos indicates that the sample plot area is typical of the whole stratum as shown

on the photos. In doubtful cases the benefit of the doubt will be given to the original interpretation and no changes made.

The field supervisor may indicate certain areas which are to be given a special check even though no volume sample locations fall in there. In such cases sufficient roads, trails, or vantage points in the area will be visited so as to provide a satisfactory check of the interpretation of the area. Field crews will prepare and keep current a list of all photos in each quadrangle on which they have made corrections. This list will be kept in the quadrangle folder.

If it is necessary occasionally for the field crews to use photos on which only the sampling points have been classified and labeled, they should in addition to checking the sample point classification add occasional notes on the photo identifying types and stand-size classes for the later use of the interpreter in completing the map. No type lines should be drawn except in case of burns, heavy cutting, etc. which have taken place since the photos were taken.

FIELD PLOTS

Locating the Plot

Volume plots are normally located on the ground by chaining or pacing from an easily identified reference point. This procedure is always used unless it is possible to locate the pinpricked point directly from the photos. Both distance and angles can be measured on the aerial photographs.

Since the orientation of the photos with true North is seldom known the bearing from reference point to plot center is established by referring the measured angle to a base line whose bearing can be determined on the ground. Preferably base lines should form an angle of at least

20 degrees with the course line from RP to plot center.

CHECK OF PHOTO INTERPRETATION

When field work is completed in a quadrangle all photos for that quadrangle should be returned as soon as possible to the interpreting unit concerned for correction of the mapping as indicated by the field corrections. The interpreting unit should keep a record of the number and kind of errors found by the field crew as a means of analyzing the sources of error in interpretation.

The interpreting unit should re-examine the photos of the quadrangles returned from the field as soon as possible and send them on to the transfer unit.

Establishing the base line - Base lines may be of two general types, those which pass through the reference point and those which do not. In rough topography base lines established either through or near the RP will usually have less chance of error due to radial displacement. However, it is often advantageous to establish a base line before reaching the RP. Base lines should be reasonably level and about the same elevation as the sample plot.

(a) Base line through reference point - Select a tree, rock, or other landmark on your photos which will be visible from the RP.

Draw a pencil line through the RP and the selected landmark. Orient your scale protractor over the RP with the "0" line through plot center and read the angle with the base line. Set your compass up at the RP, sight it at the selected landmark and read the bearing of the base line. Using this bearing and the measured angle, compute the bearing from RP to plot center.

(b) Base line not through reference point - While en route to a reference point select any road tangent, fenceline, or other line visible on your photos and on the ground. Lacking these use a line between two trees or other landmarks. Read the bearing of this line. Orient your scale protractor on the photo with the center over the base line and the "0" line cutting both RP and plot center. Read the angle and convert to course bearing.

Establishing the reference point - In some cases it will be possible to go directly to the pinpricked plot center without establishing a reference point and following a calculated course and distance to the sample location. However, in most cases the plot center can be more readily located

by means of the reference point. The following procedure should be used in selecting and establishing a reference point:

Locate an object on the photo, near the pinpricked plot center, that can be readily identified on the photo and on the ground. This is usually, but not always, a tree. Sometimes a rock, house, fenceline, power line, or some other object will serve as well or better. The more permanent the object the greater its usefulness as a reference point. Next, travel in the field to this RP. Locate the RP on the photo, using a stereoscope, and prick its location through the photo. On the back of the photo, circle the pinprick and label it with the letters "RP." In addition identify the RP as a tree, rock, etc. If it is a tree note species and diameter. Note the distance and bearing to the first sample plot. Repeat this descriptive information on the first plot record sheet and include a description of how to reach the RP and any additional notes which will help to relocate it, such as location relative to outstanding physiographic features.

Blaze the RP tree with two notches about 2 feet apart vertically, between these make a blaze large enough to contain the scribing "RP." These blazes should be on the side facing the most logical direction of approach. In some instances it may be desirable to blaze the tree on more than one side. (See page 85, Appendix A.)

Determining elevation - Each field crew will be issued a pocket aneroid barometer-altimeter. With this instrument and such controls as bench marks, airports, etc. as may be available they will be expected to determine and record the elevation of each sample plot. In addition this determination of elevation provides one basis for adjusting photo scale at the RP.

Declinations

The declinations as taken from the latest aeronautical charts and shown below by sampling units will be used for all plot location work. All compasses will be set off by these amounts, according to the sampling unit in which they are used.

<u>Sampling Unit</u>	<u>Declinations</u>
Black Hills	14° E
Pike	"
San Isabel	"
San Juan	"
Arapaho	14½° E
Grand Mesa - Uncompahgre	"
Gunnison	"
Rio Grande	"
White River	"
Medicine Bow	15° E
Roosevelt	"
Routt	"
Big Horn	16° E
Shoshone	17° E

Upon entering a new work area the altimeter should be calibrated to some bench mark such as an airport or known elevation of a town and with this as a base the elevation of the crew base headquarters such as ranger station, guard station, motel, etc., determined.

While working out of this headquarters the elevation at that point will be the base elevation. Every morning before departing for work the altimeter should be checked to this base elevation. The elevation at the sample plots will be recorded as read from the altimeter, ignoring the effect of atmospheric pressure changes.

By calibrating the altimeter to known elevations wherever possible, and noting elevations at various points the crew should be able to carry a base elevation sufficiently accurate for our purposes.

Determining photo scale in the field - The nominal scale of the photo project will be given field crews. However, this average scale applies only to the specified datum plane, and may vary considerably throughout the photo in areas of high relief. The scale varies according to elevation difference; mountaintops being closer to the camera have a larger scale. It must be adjusted for elevation change. (See Appendix table No. I, Adjustment of photo scale for elevation difference.) The local scale is determined as follows:

- (a) Determine scale of photos at datum (project scale).
- (b) Estimate elevation difference above or below datum from barometer reading, or other means.
- (c) Enter table opposite elevation difference and read scale change underneath focal length of camera. If elevation is above the datum the denominator of the representative fraction will be reduced, if below datum the denominator will be increased.

(d) Adjust the scale by the indicated change, rounding to nearest 1,000 units.

EXAMPLE: Your standard 8.25-inch F.L. photos are scaled 1:24,000 at datum (7,000 feet above sea level). At the plot the aneroid barometer reads 8,500 feet (1,500 feet above datum). What is the scale at the plot?

1. Enter the table with the elevation difference of 1,500 feet and read the scale change of 2,200 under 8.25 inches.

2. Correct scale is therefore $1:24,000 - 2,200 = 1:21,800$ at the plot, which would be rounded to 1:22,000.

3. Had the plot been 1,500 feet below datum the correct scale would have been $1:24,000 + 2,200 = 1:26,200$, rounded to 1:26,000.

Scale for a specific plot location is best determined by a scale line nearby and at same general elevation as the plot. The procedure is as follows:

1. Select two intervisible landmarks readily identified on your aerial photos, and located at approximately the same elevation. They should be at least 5 to 10 chains apart.

2. Chain or pace accurately the distance between them.

3. Scale the distance on your photo in chains, using the 1:20,000 scale.

4. Convert this by substituting into the following equation:

$$R/F = \frac{\text{Photo distance}}{\text{Ground distance} \times 20,000}$$

The table, "Adjustment of chainage for scale differences" in the Appendix will aid you in making this conversion.

EXAMPLE: The scale line is paced at 12 chains on the ground and measures 8 chains on the photo using the 1:20,000 chain scale. To find the correct photo scale:

1. Under the column headed 8 chains at 1:20,000 scale drop down to 12.00 chains.

2. Opposite 12.00 chains note the correct scale as 1:30,000.

3. Opposite 1:30,000 under column 1 note the figure 1.50 chains.

Distances scaled on the photo with the 1:20,000 rule must be multiplied by 1.5 to get correct ground distance, i.e., a distance scale as 5 chains on the photo would actually be 7.5 chains on the ground.

Sometimes it is advantageous to use a scale line measured along a road near your camp.

EXAMPLE: A straight stretch of road is clocked at 0.6 mile by your auto speedometer. The same stretch measured 40 chains on the photo using 1:20,000 chain scale.

1. 0.6 mile = 48 chains

2. Reduced $\frac{48}{40} = \frac{6}{5}$

3. This can be converted as $\frac{6}{5} \times 20,000$, or using the table, under column 5 we drop down to 6 and find it opposite 1:24,000.

When base scale is determined in this manner it is adjusted in the manner explained above for elevation differences between scale line and the plot.

When the correct scale at the location is determined enter this on the back of the photo as shown by the example on page 24.

Locating the volume sample plot - With the reference point located and marked and a base line established, determine the bearing from the reference point to the marked plot location by the methods described before. Using the proper scale and the methods set forth in the section "Determining photo scale in the field," page 48, scale the distance in chains from the RP to the corner with the transparent scale protractor.

Record this bearing and distance on the Sample Plot Record and on the back of the photo with the RP location pricked on it.

Use the staff compass to find the course, and pace or stick pace the required distance from the RP to the plot location. Compare this location with that shown on the photo, and shift as required to match ground and photo locations as nearly as possible. Type or cover should not be allowed to influence this shift in any way.

Establishing the Sample Plot

The center of the volume sample plot will be at the end of the fieldman's last step of the paced course to the plot from the RP or from another plot, except as modified above. If stick pacing is used the plot center will be the end of the last "stick" of the measured course.

Stake and witness all sample plot centers in the following manner:

- (a) Drive the treated wooden stake into the ground to mark the plot center.
- (b) Set up the staff and compass at the plot center.
- (c) Select two trees as witness trees, nearly at right angles to each other, preferably off the 1/5-acre plot. The selected trees should be ones likely to survive 10 or 15 years. Pole trees or unmerchantable sawtimber trees are preferred. One tree should be as nearly as possible

on the extension of the bearing followed pacing into the plot and the other nearly at right angles to this bearing. The tree on the extension of the plot bearing will be scribed "X" and the other tree left unmarked.

(d) Record the bearing to each of the two witness trees on the sample plot diagram, along with the species. Record also the identifying symbol "X." (See example on Sample Plot Record)

(e) Measure the slope distance from the plot center stake to breast height of each of the witness trees and record it to the nearest 1/10-foot beside the species symbol as shown on the Sample Plot Record.

(f) Determine the dbh to the nearest 1/10-inch and record it beside the species and identifying symbol as shown on the Sample Plot Record.

(g) Blaze and scribe each witness tree on the side toward the plot center with a blaze through the bark to the wood above breast-high point and a narrow notch above and below it. Scribe the proper symbol in this blaze. Place the scribe marks at a slight diagonal to the grain of the wood. (See page 85, Appendix A.)

(h) Complete filling out the heading of the Sample Plot Record before taking any plot measurements.

Making Plot Measurements

All sample plots will be circular and will have a common center. Measure and record first the 1/500-acre plot, followed in order by the 1/50-, 1/5-, and 1/3-acre plots.

Measure and record consecutively in a clockwise direction from the true North line all trees except salvable dead and seedling-sapling trees. When two trees occur on the same azimuth, measure and record the tree nearest the plot center first. Seedling-sapling and salvable dead trees

are not recorded in consecutive order because they are tallied by number of trees of a given class, not singly.

Diameters - Mark the breast-high point of all trees by a horizontal bark scratch with the tree marker prior to measuring diameter. Measure the diameter immediately above this scratch with the lower edge of the tape on the upper edge of the scratch. If the tree is also a growth sample tree (see requirements of Growth Sample Tree, page 56 make a vertical slash about 3 inches long beginning about 1/2-inch below the dbh mark. (See diagram on page 88.)

The breast-high point may be quickly determined with sufficient accuracy if each man will reference the 4-1/2-foot point on himself by a shirt button, pocket flap, or pencil mark. In practice he can step up to the tree at the mean ground level--between uphill and downhill side of the tree--and quickly find the breast-high point.

Abnormal dbh - If the normal dbh cannot be measured because the tree forks at or below breast height, the tree will be tallied as two stems, and the diameter 3-1/2 feet above the fork should be estimated for each stem. Heights should be measured for each stem. Stems will be considered as in or out on the same basis as normal trees, i.e., distance from plot center to point of measuring dbh. (See section on plot radii.) Trees which fork above the breast-high point will be tallied as one tree and given the height of the longest stem.

The dbh of swell-buttred trees should be estimated or measured at the top of the swell. Diameters should not be measured over lumps and limb swellings even though they are at the 4-1/2-foot point. Measure the diameter above or below these swellings, where the tree is of

normal diameter. The bark should always be scribed just below the point of actual measurement.

Plot radii - Plot radii will be measured from the center stake to the face of the line tree at breast height. Line trees will be out if this distance plus one-half the diameter of the tree exceeds the corrected plot radius.

For the 1/50-acre plot, 16.65-foot radius, the corrected radius as measured from the center stake to breast height on level ground is 17.2 feet

($4.5/16.65 = 27\%$ slope; corrected radius 17.2)

Plot radii on slopes will be corrected for slope as follows:

1. The man at the plot perimeter will obtain an Abney level reading in percent from breast height of the line tree to the top of the center stake.

2. The man at the plot center will retain the tape case and will let out the required length of tape for the percent of slope according to the table of plot radii by percent of slope.

3. The radius will be measured from the top of the stake at plot center to the breast-high point of the line tree, plus one-half the dbh. (See page 87.)

Recording - One man, the recorder, should stay near the plot center to record the data. The other man, the estimator, will make the measurements and call out the data. The recorder at the plot center will repeat this information aloud and record it on the Sample Plot Record. The recorder at the plot center will also assist in measuring the distance to line trees, in determining the proper slope distance for plot radii, in seeing that the trees are recorded in the proper order, and that no measurements or trees are missed. Both men will be responsible for obtaining and recording all the required data.

Record all trees on each plot by species and diameter, then measure and record heights and other pertinent data. If no data are present for a category as shown on the Sample Plot Record, draw a diagonal line through this section to indicate that the item has not been overlooked.

Data To Be Recorded

Inventory trees -

1/500-acre - Seedling-sapling plot - radius 5.26 feet - Record all trees 1/2-foot high through 4.99 inches dbh by species code, size class code, and number of trees, in the space provided on the back of the Sample Plot Record. Record species by 2-digit code and size class by 3-digit code as shown on pages 98-100.

On the 1/500-acre seedling-sapling plot only seedling and sapling trees are recorded.

1/50-acre - Pole tree plot - radius 16.65 feet - Record consecutively from the North line all live trees 5.0 inches dbh and larger by species code, dbh to nearest 0.1-inch, total height to the nearest foot. Indicate the quadrants NE, SE, SW, NW in the space provided. Enter the plot size code for each tree as follows:

<u>Tree size</u>	<u>Plot size code</u>
5.0" - 10.9" dbh incl.	2
11.0" / dbh	5

For trees 11.0 inches dbh and larger record also the number of logs to the specified top diameter (see page 20). Enter merchantability class code for each tree according to code on page 96. Enter percent of defect, board foot and cubic foot, as a 2-digit number, for all live trees, including cull trees, over 11.0 inches dbh. See page 63 for method of

determining percent of defect. Record diameters in 3-digit codes thus:

6.1"	record	061
7.0"	record	070
12.4"	record	124

Record heights in 3-digit codes thus:

50'	record	050
65'	record	065
110'	record	110

Skip one or more lines after completing the tally of the 1/50-acre plot and before beginning the tally of the 1/5-acre plot.

1/5-acre - Sawtimber tree plot - radius 52.67 feet - Record consecutively from the North line and by the proper quadrants all live trees 11.0 inches dbh and larger not previously recorded on the 1/50-acre plot, by species code, dbh to nearest 0.1 inch, total height to the nearest foot, and number of logs to the specified top diameter. Enter plot size code "3" for all trees 11.0 inches / dbh tallied on the 1/5-acre plot. Enter merchantability class code for each tree according to code on pages 96, 102. Show log height as "0" for rotten or sound cull trees. Enter percent of defect, board foot and cubic foot, as a 3-digit number, for all live trees 11.0 inches dbh and over. See page 63 for method of determining percent of defect. Record diameters and heights in 3-digit code as shown above.

Growth sample trees - Special measurements will be made on these trees to supply information on growth and log quality. The trees selected for these measurements will be the first inventory tree recorded in each 2-inch dbh class. For the 6-inch, 8-inch, and 12-inch classes the first two trees recorded, if that many are present, will be selected as sample trees in order to get a better measure of ingrowth into the pole and

and sawtimber size classes. Only diameter class will be considered in selecting the sample trees. The tree or trees selected in each diameter class will be considered as a sample of all trees of that diameter class on the plot regardless of species. Growth sample trees are marked on the side toward the plot center by a vertical slash in the bark about 1/2-inch below the horizontal dbh mark.

Rotten cull trees, sound cull trees, trees with abnormal dbh or broken, dead, or missing tops, and seedling-sapling trees will not be used as sample trees. Trees with abnormal dbh or broken or dead tops may be used as growth sample trees only if no other sample is available in the particular 2-inch diameter class.

The sample tree measurements for growth will be:

1. Present total height - Recorded to nearest foot under "INVENTORY."
2. Total height 10 years ago - Measure or estimate top growth in past 10 years, subtract this from the present total height and record the result to nearest foot. Top growth can usually be estimated by counting downward the whorls of limbs in the top. In old flat-topped trees usually no height growth is found.
3. Bark thickness - Measure the thickness of bark at breast height with the increment borer and engineers rule. Bark thickness measurements should be taken through the plates not through crevices, otherwise an underestimate of bark thickness will be obtained. Record thickness to nearest 0.05-inch as a 3-digit number as 005, 015, 105, etc.
4. Radial growth - Count the rings in from the outer end of the wood core and mark the 5- and 10-year points. Measure the radial growth of wood on the core from the outer edge of the last complete summer wood

ring to the outer edge of summer wood ring 5 years ago and to the outer edge of the summer wood ring 10 years ago. The use of the hand lens will help in counting off the rings and measuring the growth. Record the readings for the 0-5 and 0-10 year periods to the nearest 0.05-inch as a 3-digit number as 020, 105, etc.

When measuring with the 20ths side of the rule, the number of hundredths equals 5 times the number of 20ths read on the rule, e.g.,

$$\frac{13}{20} = 065 \quad \frac{25}{20} = 125 \quad \frac{7}{20} = 035$$

When boring trees for growth measurements, bore them immediately below the point marked for dbh measurements on the side facing the plot center if possible.

5. Log grade - Each log of each sample tree will be assigned a grade number according to the log grade specifications on pages 90-91. This grade number will be entered in the space under the appropriate log number and a line drawn through all the unused spaces. Cull and missing logs should be given code number 0 as a grade in whatever position they appear. In the case of pole-sized trees a line will be drawn through all the log grade spaces.

Mortality trees - Mortality trees will be tallied on the 1/3-acre circular plot (radius 67.98 feet). Record consecutively, beginning from the North line and proceeding clockwise, all standing and down trees over 5.0 inches dbh judged to have died within the past 5 years. (See definition of mortality trees, page 19.) Record species code, 0.1-inch dbh class, total height to the nearest foot, and cause of death code. Dbh and heights will be entered as 3 digits, e.g., dbh classes 20.1 inches, 8.2 inches, and 12.3 inches will be entered as 201, 082, and 123 respectively; heights 75 feet, 52 feet, and 103 feet will be entered as 075, 052, and 103 respectively.

All mortality trees will be marked with two axe cuts into the wood below stump height on the side facing the plot center. Trees which have died within the past five years, but are not counted as mortality because they were culls at the time of death will be marked with a single flat blaze below stump height.

Primary causes of death classes recognized and recorded are:

Insects (Code 1) - Dead trees which exhibit evidence of having been attacked while in the live state by insects of a type and in sufficient numbers to have caused death.

Disease (Code 2) - Dead trees which exhibit evidence of diseases capable of causing death, such as mistletoe, blister rust, *Fomes pini*, *Cronartium rust*, etc.

Fire (Code 3) - Dead trees which show evidence that they have been subjected to fire of such extent and intensity as would likely have caused their death.

Weather (Code 5) - Dead trees which show evidence of having died as a result of the effects of weather. This includes death due to windthrow and breakage, flooding from causes other than animal, including man, ice and snow, lightning, winterkill, drought, sun scald, etc.

Animal (Code 6) - Dead trees which show evidence of having been killed by the action of animals. This includes trees girdled by porcupines, bear, squirrels, or antlered animals, cut or inundated by beaver, and trees broken or girdled by grazing animals.

Other (Code 4) - Dead trees which show no evidence of having been killed by any of the foregoing five agents. This category includes trees

dead as a result of suppression, landslides, smelter fumes, vehicles, recreation, etc.

Salvable dead trees - Salvable dead trees, including mortality trees meeting the definition of salvable dead on page 19, will be tallied on the 1/5-acre circular plot. Record by species code, 2-inch dbh class, total height to nearest 5 feet, merchantability class, and number of trees of the same species-dbh-height class. Diameters and heights will be recorded as 3-digit entries as described under Mortality trees.

Merchantability classes recognized and recorded for salvable dead trees are:

8 - Suitable for lumber

0 - Suitable for uses other than lumber, e.g., fuelwood, pulpwood

For the definition of salvable dead trees and the two merchantability classes see page 19.

Site tree - Select an average dominant or co-dominant tree for the stand at each plot and record species, dbh, total age to the nearest year, and total height to the nearest foot in the spaces provided at the top of the Sample Plot Record. The tree selected for the site tree can be one of the sample trees if it is an average dominant or co-dominant.

Use sawtimber trees in sawtimber stands and pole trees in pole stands for site measurements where possible. Use a tree of the type species if possible, i.e., a ponderosa pine tree for ponderosa pine type, Douglas-fir for Douglas-fir type.

If no tree on the plot is considered an average dominant or co-dominant for the stand a tree off the plot may be selected and a notation made to that effect.

ESTIMATE OF DEFECT

One of the most difficult jobs in connection with the measurement of the volume sample plots is that of making an estimate of the amount of defect present in standing trees. Since it is not possible to examine the logs after the trees have been bucked up for evidence of rot or to see how such things as crook, sweep, forks, etc. actually turn out, the fieldman must make his estimate on the basis of what he can see in the standing tree.

During the process of obtaining and recording the species, dbh, total height, and saw log height of all live inventory trees 11.0 inches dbh and over, all sides of the trees should be examined for evidence of defect, including boring of trees suspected of containing hidden defect. Some of the visible evidences of defect are conks or fruiting bodies of fungi, swollen knots, black or bleeding knots, crook and sweep, fire scars, forks, lightning scars, frost and wind cracks, and top injuries. In addition the sound of a tree when struck with an axe may frequently indicate rot within. Whenever evidence of defect is found, an estimate of the percent of defect in terms of the whole tree will be made on both a board-foot and cubic-foot basis and entered on the Sample Plot Record.

Cubic-foot defect will include only those defects which reduce the solid wood content of the tree between a 1-foot stump and a 4-inch top dib. Types of defect which reduce the cubic-foot volume are (1) rot, and (2) missing sections such as broken tops and stems and sections destroyed by fire or other cause.

Board-foot defect will include only defects which reduce the lumber content of a tree between a 1-foot stump and a merchantable top dib. Defects which lie outside the slab collar of a log do not constitute a loss of board-foot volume. Types of defect which reduce the board-foot volume

are:

- (1) Rot
- (2) Fire scars
- (3) Missing bole sections
- (4) Serious crooks
- (5) Forks
- (6) Lightning scars and frost and wind cracks

Of these types of defect, only the first three will also reduce the cubic-foot volume of wood in the tree.

For the purposes of estimating the percent of board-foot defect due to crooks, forks, and lightning scars, and the cubic-foot defect percent due to fire scar types of defect, the tree will be considered as being divided into 16-foot logs, and each log further divided into 4-foot sections. The logs will begin at the 1-foot stump and run to the top diameters as specified on page 20. Tables III and IV on page 79 show the estimated percent of total tree volume by the 4-foot sections for cubic-foot and board-foot (INT 1/4") volume. The sum of defect percent estimates for individual sections multiplied by the percent of total tree volume represented by these sections will provide the estimate of defect percent of total tree volume. If the defect percent estimate for the total tree is 67 percent or more the tree will be recorded as cull.

In estimating board-foot defect, where such defect reduces the usable length of a 4-foot section more than half, then the entire length of the section will be considered lost. Where the reductions in length, due to defect, is up to but not more than half, then one-half of the

length of the section will be considered lost. If the usable length of a log is reduced to less than 8 feet the entire log should be considered lost. If the usable volume of any log is less than one-third the entire log should be considered lost.

For the purposes of estimating the percent of defect, both board-foot and cubic-foot, due to circular interior defect, and the board-foot defect due to catface fire scar types of defect, the dimensions of the defect will be estimated or measured and the volume of the defect section obtained from Tables V and VI. This volume will then be compared with the total volume of the tree from Tables VIII and IX and entered on the Sample Plot Record as a percent of the total tree volume.

Procedure for Estimating Defect

Serious crook or sweep - No deductions will be made for crook and sweep other than for short, sharp crooks which cannot be handled by proper bucking. Such crooks will be considered as causing the loss of half or all of the particular 4-foot section, and a corresponding part of the total board-foot volume of the tree. No cubic-foot defect will be allowed. **EXAMPLE:** 4-log tree with sharp kink in first 4 feet of third log; the entire 4-foot section will have to be cut off in the woods. Board-foot defect percent from Table IV is 5 percent.

Forks - The estimate of board-foot defect percent for forks will be obtained by estimating the portion of the length, all or one-half of the 4-foot section, which will be lost in cutting out the fork and translating this into percent of total tree volume. No cubic-foot defect will be allowed. **EXAMPLE:** A 3-log tree, forking in second section of second log; cutting out a 2-foot section will be necessary. Board-foot defect percent from Table IV is 4 percent (1/2 of 8).

Lightning scars - The estimate of board-foot defect percent for lightning scars will be obtained by considering the 4-foot section or sections as being divided into quarters lengthwise. The percent loss in each quarter due to the scar will be estimated and translated into terms of the total tree. No cubic-foot defect will be allowed. EXAMPLE: A 4-log tree with 12-foot lightning scar running through last three 4-foot sections of the last log. The scar is of such depth and width as to cause the loss of one-fourth of the volume of each 4-foot section. Board-foot defect percent from Table IV is 2 percent ($1/4$ of $3 \div 2 \div 2$).

Fire scar-catface - The estimate of board-foot defect percent will be obtained by estimating the volume of the defect section, comparing this with the total volume of the tree and entering it on the Sample Plot Record as a percent of total tree volume. The estimate of the volume of the defect section will be based on the standard rule for INT 1/4-inch defect of $\frac{D \times W \times L}{16}$

Where D = Average depth plus 1 inch
W = Average width plus 1 inch
L = Length in feet of the section

Table V, "Volume of defect section, INT 1/4-inch" gives the board-foot volumes for various lengths and various D x W products and D²'s. The estimate of cubic-foot defect percent will be obtained by determining the depth of the defect at the base as a percent of average dib of the section having the defect, and using this percent and the length of defect to read the percent of cubic-foot defect from Tables VII and III. EXAMPLE: A 16-inch, 100-foot, 5-log, LP tree with a fire scar running out 6 feet above the 1-foot stump. Depth of defect at base is 6 inches; average width inside slab is 10 inches.

Depth of defect at base is $6" \div 1" \text{ less } 3" \text{ (for slab collar and taper from right cylinder) equals } 4"$.

Board-foot defect - depth of defect at top is $0 \div 1 = 1$ inch
Average depth is $\frac{4 \div 1}{2} = 2\text{-}1/2$ or 3 inches

Average width is given as 10 inches; $W = 10 \div 1$ or 11

Product of $D \times W$ is $11 \times 3 = 33$

Volume of defect section from Table V is 12 board feet

Gross volume of tree from Table IX is 336 board feet

Defect percent is $\frac{12}{336} = 4$ percent of total tree volume

Cubic-foot defect - average dib of section containing defect is 15 inches, taking into consideration taper and bark thickness. The defect at the base extends 5 inches inside this average dib or defect depth is 33 percent of dib.

From Table VII defect percentage for a defect of this depth and length is 5 percent of the cubic-volume of an 8-foot section. From Table III the cubic-defect percent for the tree is 5 percent of the first 8-foot section or 5 percent of $(10 \div 9) = 1$ percent.

Circular interior defect - The estimate of defect volume, board-foot and cubic-foot, will be obtained by first measuring or estimating the average diameter plus 1 inch and the length of the defect section squaring the diameter plus 1 inch, and then reading the volume of the section from Table V and VI. The volume of the section will then be compared with the total tree volume from the volume tables provided and entered on the Sample Plot Records as a percent of the total tree volume. The estimate of average diameter of the defect section will be obtained primarily from increment borings. The estimate of length should be based on any evidence available such as conks, punk knots, bleeding knots, and the fieldman's experience and knowledge of the behavior of similar rots in similar timber. EXAMPLE: A 16-inch, 90-foot PP tree with a circular interior defect section estimated

to have an average diameter of 5 inches and a length of 16 feet.

$$\text{Board-foot defect percent} = (D \div 1)^2 = (5 \div 1)^2 = 36$$

From Table V, the volume of the defect section is 36 board feet.

From Table IX the board-foot volume of the tree is 267 board feet.

$$\text{Board-foot defect percent} = \frac{36}{267} \text{ or } 13 \text{ percent.}$$

Cubic-foot defect percent - Diameter = 5 inches. From Table VI the volume of the defect section is 2 cubic feet. From Table VIII the total tree volume is 46 cubic feet. Cubic-foot defect percent is $\frac{2}{46}$ or 4 percent.

EXPLANATION OF ITEMS ON SAMPLE PLOT RECORD

Front of Sheet

HEADING

Loc. and Plot No. - Record as 3-digit code followed by a dash and the number of the circular sample plot

Examples: 001-1
015-2
102-1

State - Enter code number

(For code numbers of all items on plot sheet see pages 92-100.)

Sampling Unit - Enter name and code number of sampling unit.

Subunit - Enter name and code number of working circles.

County - Enter name and code number.

Ownership - Enter ownership class and code number. (If not known in field, leave blank and this will be entered in office.)

<u>Type</u>	(Enter opposite (P) the symbols only for these
<u>Stand-size Class</u>	items for the area stratum in which the volume
<u>Crown Density</u>	sample falls as they were shown on the photo by
	(photo interpretation alone. Enter opposite (F)
	(the symbols and code numbers for the same area
	(stratum after field checking.

Photo Numbers - Enter the project symbol, roll number, and photo numbers of all the photos used for the location.

Example: DUV-6F, 22-25

Sec. - Enter the number of the section in which the sample location falls.

Twp. (Enter the township and range in which the sample location falls. Example: Twp. 16N Rge. 7W

Elevation - Enter the elevation of the sample plot cluster above sea level in feet. This will be determined with an aneroid barometer as described on pages 47-48.

Site Tree - Record species, diameter to 0.1 inch, height to nearest foot, and age to nearest year of the tree selected as the site tree.

<u>Recorder</u>	)
<u>Date</u>	(Enter last name and date.
<u>Estimator</u>	)
<u>Date</u>	)

INVENTORY

Quadrant - Enter NE, SE, SW, or NW as appropriate.

Plot Size - Enter code number.

Species - Enter code numbers.

DBH - Enter diameter to nearest 0.1 inch in 3-digit code.

Examples: 7.1" = 071
9.0" = 090
12.1" = 121

Total Height - Enter total height to nearest foot in 3-digit code.

Examples: 75' = 075
90' = 090
124' = 124

MC - Enter merchantability class code.

Log Ht. - For all noncull trees over 11.0-inch dbh, enter number of 16-foot logs to nearest log to specified top dib. For all cull trees and trees under 11.0-inches dbh enter "0."

CD)
No. of Trees (No entry required.)

Defect Percent

Board Feet (Enter 2-digit figure for estimate of percent of Cubic Feet (tree defective. If no defect enter "00.")

Volume - Office entry.

GROWTH (Sample trees only)

Tot. Ht. 10 yrs. ago. - Enter estimated total height 10 years ago to nearest foot in 3-digit code. Obtained by estimating height growth in past 10 years and subtracting this from present total height.

Bark Thk. - Enter bark thickness as measured by increment borer and engineers rule to nearest 0.05 inch in 3-digit code.

Rad. Gr. - 0-5 years Radial growth of wood in past 5 years to nearest 0.05 inch in 3-digit code.
0-10 years Radial growth of wood in past 10 years to nearest 0.05 inch in 3-digit code.

LOG GRADE (Sample sawtimber trees only)

For each log of sawtimber trees enter under the number of that log position the numerical code of the grade assigned to it. (See pages 90-91 for definition of log grades.)

For cull and missing logs enter code number "0" under proper log position. For pole trees enter a dash,

Back of Sheet

MORTALITY

Species - Enter code number.

1/10" DBH Class - Enter diameter to 1/10 inch as 3-digit code.

Examples: 8.1" = 081
10.2" = 100
12.3" = 123

Total Ht. - Enter total height to nearest foot in 3-digit code.

Examples: 71' = 071
105' = 105

MC - No entry required.

Log Ht. - No entry required.

CD - Enter code number for the estimated cause of death.

YD - No entry required.

SALVABLE DEAD

Species - Enter code number

2" DBH Class - Enter diameter by 2-inch classes in 3-digit code.

Examples: 12.3" = 120
6.6" = 060
13.6" = 140

Total Height - Enter height to nearest 5-foot height class in 3-digit code.

Examples: 73' = 075
61' = 060
104' = 105

MC - Enter merchantability class code.

Log Ht. (No entry required.
CD)

No. of Trees - Enter here in 2-digit code the number of trees for each species-dbh-height combination.

Examples: Two trees - LP, 8", 65' = No. of trees = 02
One tree - S, 12", 70' = No. of trees = 01

SEEDLING-SAPLING

Species - Enter code number.

Class - Enter here 3-digit code numbers for classes of seedling-sapling trees.

Total Ht.)
MC (No entry required.
Log Ht.)
CD)

No. of Trees - Enter here in 2-digit code the number of trees for each species-dbh-height class combination.

PLOT SKETCH

Draw lines from center point to approximate diagrammatic locations of witness trees. Record bearing to tree on the upper side of the line, and distance on the lower side of the line. Indicate species and dbh of each witness tree, and which one is scribed "X."

REFERENCE POINT

Brief description of how to reach RP and what it is, e.g., "Follow Smith Creek road to trail up Alder Gulch. Go up this trail approximately 75 chains to top of ridge and go east along the ridge approximately 25 chains to clump of aspen. RP is 24-inch DF on west edge of clump."

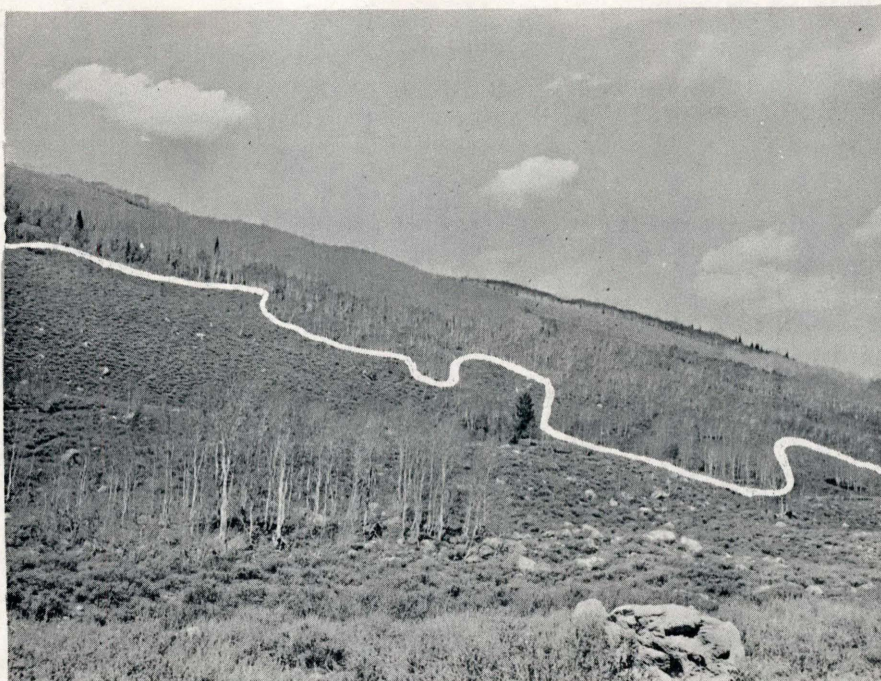
Brg. - Enter bearing from RP to plot 1, or from plot 1 to plot 2.
Example: N 74° E.

Dist. - Enter distance from RP to plot 1 or from plot 1 to plot 2.
Example: 4-1/2 ch.

APPENDIX A

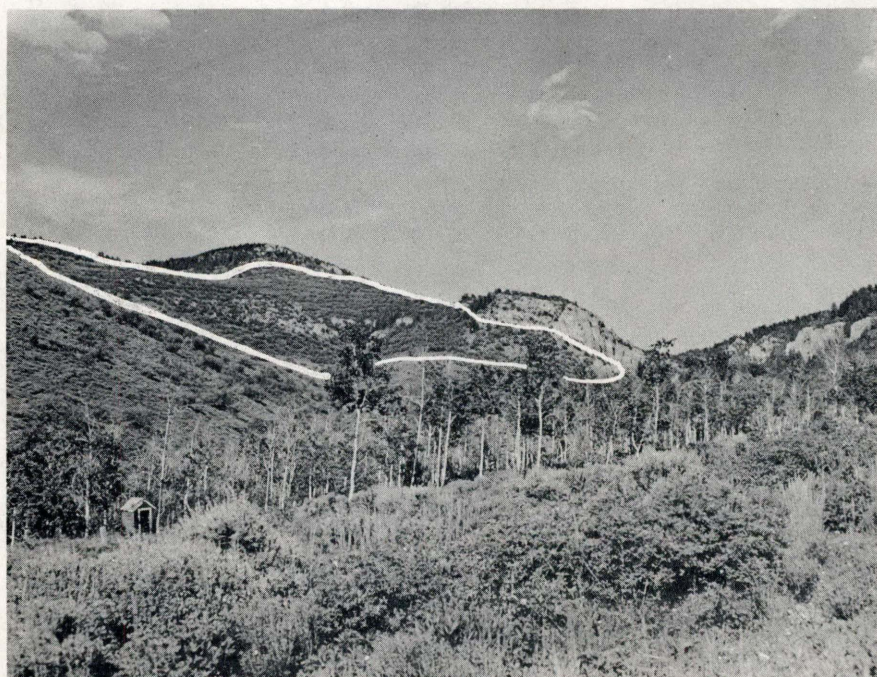
Photographs of some noncommercial forest land	<u>Page</u> 72
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SOME EXAMPLES OF NONCOMMERCIAL FOREST LAND



Noncommercial forest land - Aspen cover - Map symbol NA

Note scrubby appearance of aspen and almost total lack of conifers.

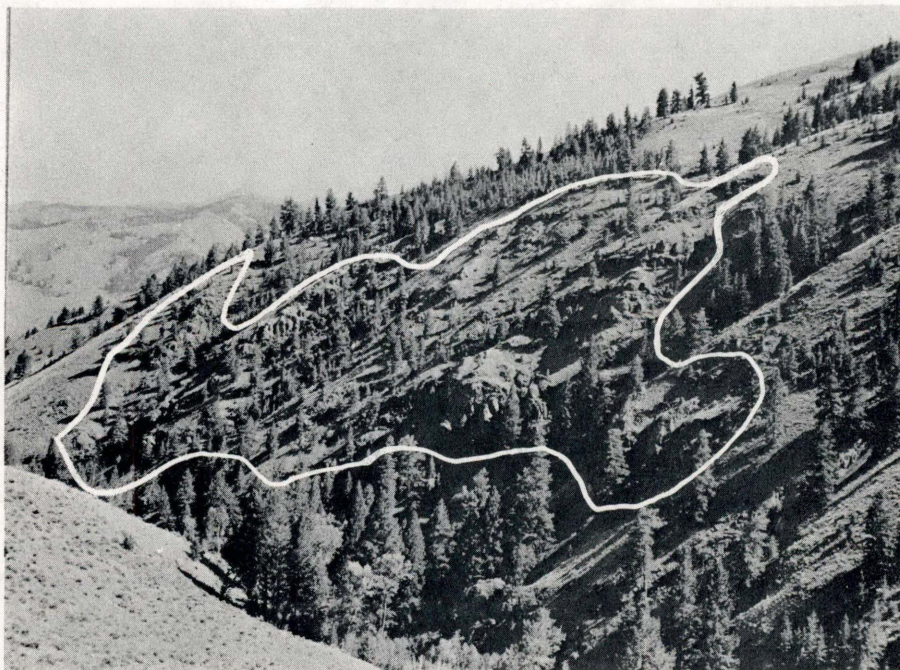


Noncommercial forest land - Chaparral (Mountainmahogany) - Map symbol NC



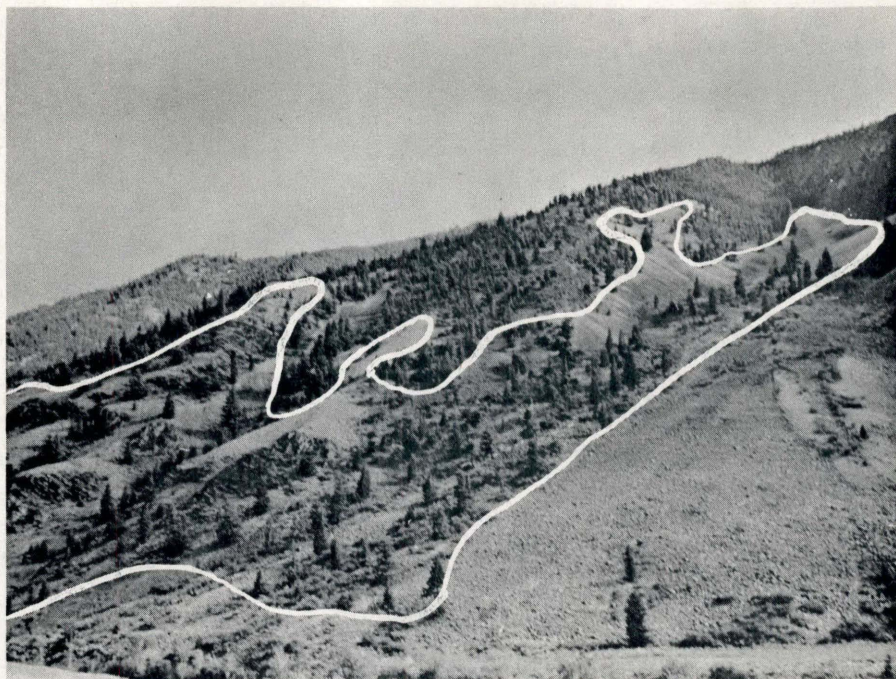
Noncommercial forest land - Other - Map symbol NO

Rough trees near upper limits of tree growth; steep, cliffy ground.



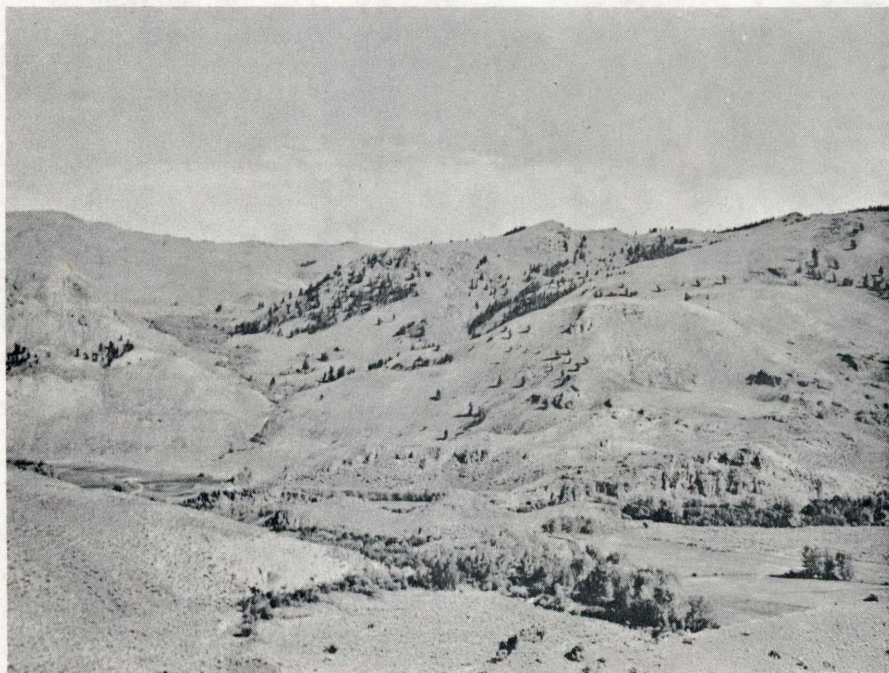
Noncommercial forest land - Other - Map symbol NO

Steep, rocky, broken slopes.



Noncommercial forest land - Other - Map symbol NO

Thin scattered stand on talus slopes. Poor soil and growing conditions. Perhaps subject to soil movement as landslides or periodic snowslides.



Noncommercial forest land - Other - Map symbol NO

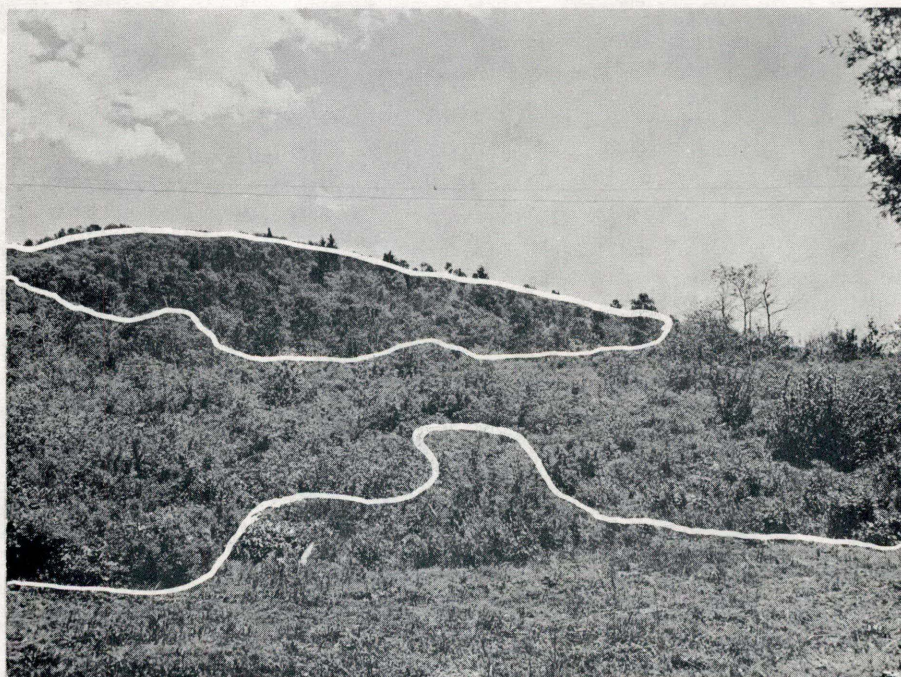
Small isolated stands, usually on steep ground, uneconomical to harvest.

COMMERCIAL FOREST LAND - ASPEN



Commercial forest land - Aspen cover - Map symbol A8W

Note thrifty appearance of aspen, frequency of conifers.



Background - Commercial forest land - Aspen cover - Map symbol A8M

Foreground - Noncommercial forest land - Chaparral (brush) - Map symbol NC



Noncommercial forest land - Pinyon-juniper - Map symbol NPJ

Table I.

ADJUSTMENT OF PHOTO SCALE FOR ELEVATION DIFFERENCE				
Elevation	Focal length of camera			
change	8.25 inches	6 inches	5.25 inches	
from	.6875-feet	.500-feet	.437-feet	
datum	Change in photo scale (R.F.)			
(feet)	U n i t s			
/ 500-	- 700/	-1000/	-1200/	
/1000-	-1500/	-2000/	-2400/	
/1500-	-2200/	-3000/	-3500/	
/2000-	-2900/	-4000/	-4700/	
/2500-	-3600/	-5000/	-5900/	
/3000-	-4400/	-6000/	-7100/	
/3500-	-5100/	-7000/	-8200/	
/4000-	-5800/	-8000/	-9400/	
/4500-	-6500/	-9000/	-10600/	
/5000-	-7300/	-10000/	-11800/	

Scale changes rounded to nearest 100 units.

To use: Determine photo scale at selected datum.

If plot elevation is above datum the change is minus.

If plot elevation is below datum the change is plus.

Table II.

ADJUSTMENT OF CHAINAGE FOR SCALE DIFFERENCE									
RF in thou- sands	Chains measured at 1:20,000 scale								
	1	2	3	4	5	6	7	8	9
	Distance converted to R/F of photo (chains)								
1:15	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75
16	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20
17	0.85	1.70	2.55	3.40	4.25	5.10	5.95	6.80	7.65
18	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10
19	0.95	1.90	2.85	3.80	4.75	5.70	6.65	7.60	8.55
20	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
21	1.05	2.10	3.15	4.20	5.25	6.30	7.35	8.40	9.45
22	1.10	2.20	3.30	4.40	5.50	6.60	7.70	8.80	9.90
23	1.15	2.30	3.45	4.60	5.75	6.90	8.05	9.20	10.35
24	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.80
25	1.25	2.50	3.75	5.00	6.25	7.50	8.75	10.00	11.25
26	1.30	2.60	3.90	5.20	6.50	7.80	9.10	10.40	11.70
27	1.35	2.70	4.05	5.40	6.75	8.10	9.45	10.80	12.05
28	1.40	2.80	4.20	5.60	7.00	8.40	9.80	11.20	12.60
29	1.45	2.90	4.35	5.80	7.25	8.70	10.15	11.60	13.05
30	1.50	3.00	5.00	6.00	7.50	9.00	10.50	12.00	13.50
31	1.55	3.10	5.15	6.20	7.75	9.30	10.85	12.40	14.95
32	1.60	3.20	5.30	6.40	8.00	9.60	11.20	12.80	15.40

Table III.--Percentage of cubic-foot volume (1-foot stump to 4-inch top dib) by 4-foot sections

Logs per tree	4-foot sections																										Top to 4" dib
	Log No. 1				Log No. 2				Log No. 3				Log No. 4				Log No. 5				Log No. 6						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			
1	31	25	21	18	95																				5		
2	20	18	15	12	65	10	9	7	5	31															4		
3	15	13	11	10	49	8	8	7	7	30	5	5	4	4	18										3		
4	13	11	9	7	40	7	7	6	6	26	5	5	5	4	19	4	3	3	2	12					3		
5	10	9	8	7	34	6	6	6	5	23	5	5	4	4	18	4	4	3	3	14	3	2	2	2	9	2	
6	9	8	7	6	30	5	5	5	5	20	5	4	4	4	17	4	3	3	3	13	3	3	3	2	11	2 2 2 1 7	2

Table IV.--Percentage of total board foot (INT. 1/4") volume by 4-foot sections

Logs per tree	4-foot sections																													
	Log No. 1				Log No. 2				Log No. 3				Log No. 4				Log No. 5				Log No. 6									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24						
1	38	28	20	14	100																									
2	23	20	16	14	73	10	8	5	4	27																				
3	18	13	12	11	54	10	8	7	7	32	5	4	3	2	14															
4	14	11	10	8	43	8	7	7	6	28	5	5	5	4	19	3	3	2	2	10										
5	12	9	8	7	36	7	6	6	5	24	5	5	5	4	19	4	3	3	3	13	2	2	2	2	8					
6	10	8	7	6	31	6	5	5	5	21	5	5	4	4	18	4	4	3	3	14	3	3	2	2	10	2	2	1	1	6

Table V.--Volume of defect section, INT 1/4"

DxW ^{1/} or Diam. ²	Length in feet									
	2	4	6	8	10	12	14	16	18	20
	.125	.250	.375	.500	.625	.750	.875	1.00	1.125	1.250
25	3	6	9	12	16	19	22	25	28	31
30	4	8	11	15	19	22	26	30	34	38
35	4	9	13	18	22	26	31	35	39	44
40	5	10	15	20	25	30	35	40	45	50
45	6	11	17	22	28	34	39	45	51	56
50	6	12	19	25	31	38	44	50	56	62
55	7	14	21	28	34	41	48	55	62	69
60	8	15	22	30	38	45	52	60	68	75
65	8	16	24	32	41	49	57	65	73	81
70	9	18	26	35	44	52	61	70	79	88
75	9	19	28	38	47	56	66	75	84	94
80	10	20	30	40	50	60	70	80	90	100
85	11	21	32	42	53	64	74	85	96	106
90	11	22	34	45	56	68	79	90	101	112
95	12	24	36	48	59	71	83	95	107	119
100	12	25	38	50	62	75	88	100	112	125
110	14	28	41	55	69	82	96	110	124	138
120	15	30	45	60	75	90	105	120	135	150
130	16	32	49	65	81	98	114	130	146	162
140	18	35	52	70	88	105	122	140	158	175
150	19	38	56	75	94	112	131	150	169	188
160	20	40	60	80	100	120	140	160	180	200
170	21	42	64	85	106	128	149	170	191	212
180	22	45	68	90	112	135	158	180	202	225
190	24	48	71	95	119	142	166	190	214	238
200	25	50	75	100	125	150	175	200	225	250
210	26	52	79	105	131	158	184	210	236	262
220	28	55	82	110	138	165	192	220	248	275
230	29	58	86	115	144	172	201	230	259	288
240	30	60	90	120	150	180	210	240	270	300
250	31	62	94	125	156	188	219	250	281	312

1/ Add 1 inch to average depth and width (or average diameter of circular defect) before determining product with which to enter table.

Based on Defect Vol. = $\frac{(\text{Depth} \div 1")(\text{Width} \div 1")(\text{Length in feet})}{16}$

or $\frac{(\text{Diam.} \div 1")^2 (\text{Length in feet})}{16}$

Table VI.--Volume of circular defect section, cubic feet

Diameter	Length in feet									
	2	4	6	8	10	12	14	16	18	20
3					1	1	1	1	1	1
4			1	1	1	1	1	1	2	2
5		1	1	1	1	2	2	2	2	3
6		1	1	2	2	2	3	3	4	4
7	1	1	2	2	3	3	4	4	5	5
8	1	1	2	3	3	4	5	6	6	7
9	1	2	3	4	4	5	6	7	8	9
10	1	2	3	4	5	7	8	9	10	11
11	1	3	4	5	7	8	9	11	12	13
12	1	3	5	6	8	9	11	13	14	16
13	2	4	6	7	9	11	13	15	17	18
14	2	4	6	9	11	13	15	17	19	21
15	2	5	7	10	12	15	17	20	22	25
16	3	6	8	11	14	17	20	22	25	28
17	3	6	9	13	16	19	22	25	28	32
18	4	7	11	14	18	21	25	28	32	35
19	4	8	12	16	20	24	28	32	35	39
20	4	9	13	17	22	26	31	35	39	44
21	5	10	14	19	24	29	34	38	43	48
22	5	11	16	21	26	32	37	42	48	53
23	6	12	17	23	29	35	40	46	52	58
24	6	13	19	25	31	38	44	50	57	63
25	7	14	20	27	34	41	48	55	61	68

Table VII.--Cubic-foot defect percentage for fire scar, catface type of defect

Depth of defect at base ^{1/} as percent of average dib of section	Length of defect in feet							
	1	2	3	4	5	6	7	8
	Percent of 4-foot section :				Percent of 8-foot section			
20	-	-	5	5	5	5	5	5
30	-	5	5	10	5	5	10	10
40	5	5	10	15	10	10	10	15
50	5	10	15	15	10	10	15	15
60	5	10	15	20	15	15	20	20
70	5	10	15	25	15	20	20	25
80	5	15	20	30	20	20	25	30
90	10	15	25	30	20	25	30	30
100	10	15	25	35	20	25	30	35

^{1/} At or above 1-foot stump.

Based on treating the defect as essentially a conical or pyramidal section, thus having a cubic volume equal to one-third that of a full section of the same basal area.

Table VIII

Table for Approximating Cubic Foot Volume of Trees for
Purposes of Estimating Cubic Foot Defect Percent

DBH	DBH ²	PP	L	LP	S
		WP Cot.	Ced. DF		AF GF Asp.
		(.200)	(.175)	(.250)	(.215)
11	121	0.24	0.21	0.30	0.26
12	144	0.29	0.25	0.36	0.31
13	169	0.34	0.30	0.42	0.36
14	196	0.39	0.34	0.49	0.42
15	225	0.45	0.39	0.56	0.48
16	256	0.51	0.45	0.66	0.55
17	289	0.58	0.51	0.72	0.62
18	324	0.65	0.57	0.81	0.70
19	361	0.72	0.63	0.90	0.78
20	400	0.80	0.70	1.00	0.86
21	441	0.88	0.77	1.10	0.95
22	484	0.97	0.85	1.21	1.04
23	529	1.06	0.93	1.32	1.14
24	576	1.15	1.01	1.44	1.24
25	625	1.25	1.09	1.56	1.34
26	676	1.35	1.18	1.69	1.45
27	729	1.46	1.28	1.82	1.57
28	784	1.57	1.37	1.96	1.69
29	841	1.68	1.47	2.10	1.81
30	900	1.80	1.58	2.25	1.94
31	961	1.92	1.68	2.40	2.07
32	1024	2.05	1.79	2.56	2.20
33	1089	2.18	1.91	2.72	2.34
34	1156	2.31	2.02	2.89	2.49
35	1225	2.45	2.14	3.06	2.63
36	1296	2.59	2.27	3.24	2.79
37	1369	2.74	2.40	3.42	2.94
38	1444	2.89	2.53	3.61	3.11
39	1521	3.04	2.66	3.80	3.27
40	1600	3.20	2.80	4.00	3.44

To use: Multiply height of tree by factor opposite DBH.

For example, PP tree, 15" dbh, 60' tall

Cu. vol. = 60 x .45 = 27 cu. ft.

LP tree, 17" dbh, 75' tall

Cu. vol. = 75 x .72 = 54 cu. ft.

Table 1X

TABLE FOR APPROXIMATING BOARD FEET INT 1/4-INCH VOLUME OF TREES
FOR PURPOSE OF ESTIMATING DEFECT PERCENT

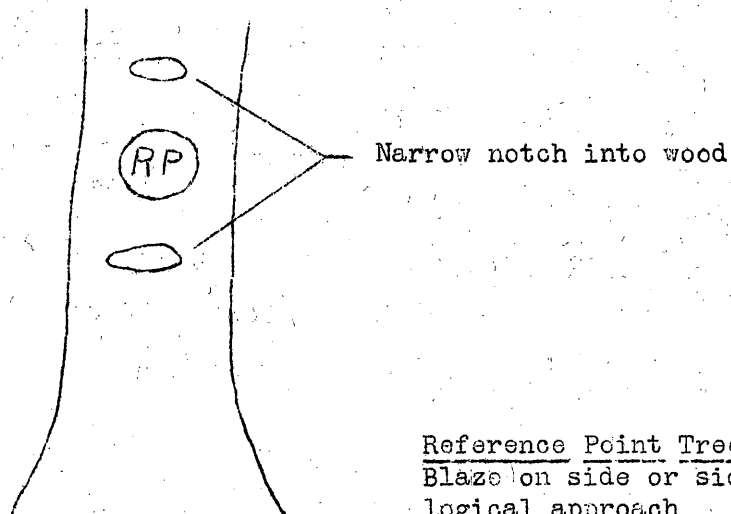
DBH In.	Volume (Board feet) by total height of trees in feet																DBH In.
	50	60	70	80	90	100	110	120	50	60	70	80	90	100	110	120	
<u>MEDIUM SITE</u>																	
	<u>WHITE PINE</u>									<u>PONDEROSA PINE</u>							
12	76	101	121	140	161	181			54	73	95	115					12
14	109	144	172	198	225	251	278		83	110	132	171	197				14
16		192	224	267	302	329	368		120	157	192	232	267	302			16
18		237	272	330	381	424	477	513	155	208	253	301	352	395	452		18
20			361	420	473	525	586	631	201	266	324	383	443	510	570	631	20
24			515	598	680	760	842	919		399	487	583	680	770	863	950	24
28				810	927	1037	1150	1257			684	816	939	1072	1207	1338	28
32				1062	1211	1357	1503	1647				1092	1268	1421	1614	1806	32
<u>WESTERN LARCH</u>																	
12	55	74	93	109	125	144			72	95	115	134	161				12
14	74	105	130	156	178	203	228		102	137	169	194	225				14
16	96	136	172	206	234	264	297	328	135	185	227	268	302	343			16
18		162	212	258	294	332	375	413		228	286	342	395	439			18
20		194	262	317	361	406	458	503		272	353	428	498	563	638		20
24			402	472	535	601	667	737			555	643	727	815	905	998	24
28			494	591	685	774	864	947			733	856	978	1096	1219	1337	28
32				713	827	954	1065	1172				1099	1265	1413	1577	1736	32
<u>WESTERN HEMLOCK</u>																	
12	64	85	106	126	148	167			63	80	97	115	132	154			12
14	95	123	155	181	217	238			88	115	137	162	190	215	237		14
16	130	167	209	242	281	321	365		117	153	185	213	247	279	302	333	16
18	163	215	268	308	368	417	476		145	189	230	272	308	352	384	424	18
20		262	332	391	458	533	600	675	187	239	288	335	383	428	480	533	20
24			521	613	707	809	918	1029	284	361	436	508	577	646	718	791	24
28				830	970	1112	1264	1407		498	575	664	770	867	965	1057	28
32				1084	1272	1456	1660	1858			720	857	999	1124	1246	1366	32
<u>ENGELMANN SPRUCE</u>																	
12	70	91	113	131	152	173			66	87	108	128	140	164			12
14	100	130	159	186	212	250	272		96	125	155	177	201	225	249		14
16	132	171	209	247	281	315	355	392	129	164	196	227	260	288	316	343	16
18		215	258	308	355	403	451	498		200	244	279	323	352	395	427	18
20		266	317	376	440	495	555	616			291	338	383	428	473	517	20
24			527	614	707	801	901	997				480	517	576	634	694	24
28			694	818	946	1073	1204	1339					676	758	842	926	28
32				1065	1225	1386	1566	1739						971	1083	1190	32
<u>ALL SITES</u>																	
	<u>LODGEPOLE PINE</u>									<u>COTTONWOOD</u>							
12	79	101	124	147	170	190			65	74	87	98	111				12
14	109	143	172	200	233	258	286		97	115	133	151	170	188			14
16	143	181	220	257	297	336	371	413	129	155	180	204	230	256	282		16
18	170	222	272	321	372	421	469	505	169	203	235	270	301	333	368	402	18
20	205	264	324	383	443	503	563	623	221	265	307	354	395	437	478	520	20
22		362	433	511	587	663	743	822	323	382	445	509	567	631	692	758	24
24			495	582	670	757	850	946		529	616	702	783	869	956	1042	28
26				653	754	860	960	1068			794	902	1010	1129	1231	1339	32

VOLUME PER ACRE REPRESENTED BY ONE TREE ON A 1/5-ACRE PLOT,
International 1/4-inch scale

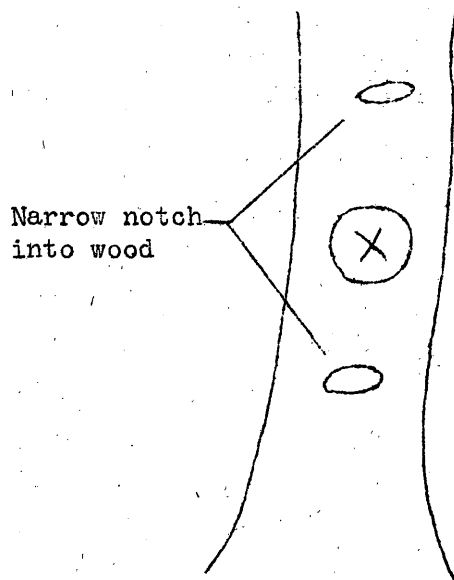
DBH Class	Height in feet						
	40	50	60	70	80	90	100
Board feet (INT. 1/4-inch)							
12	280	390	505	620	735	850	945
14	390	545	715	860	1000	1155	1290
16	505	715	910	1100	1290	1485	1680
18	590	850	1110	1360	1605	1860	2105
20		1025	1320	1620	1915	2215	2515
22		1400	1735	2165	2550	2940	3315
24			2030	2475	2910	3350	3785
26					3275	3885	4300
28					3595	4180	4665
30					3865	4530	5180

To be used by fieldmen as a guide for gauging whether or not
borderline stands should be classed as sawtimber stands--1,500 / board
feet per acre in sawtimber trees.

METHOD OF MARKING REFERENCE POINT
TREES AND PLOT CENTER WITNESS TREES



Reference Point Tree
Blaze on side or sides of most
logical approach



Plot Center Witness Tree
Blaze above breast height facing
plot center stake. Scribe "X" on
one tree

DIAGRAM OF VOLUME SAMPLE PLOTS FOR
TALLY OF ALL TREES

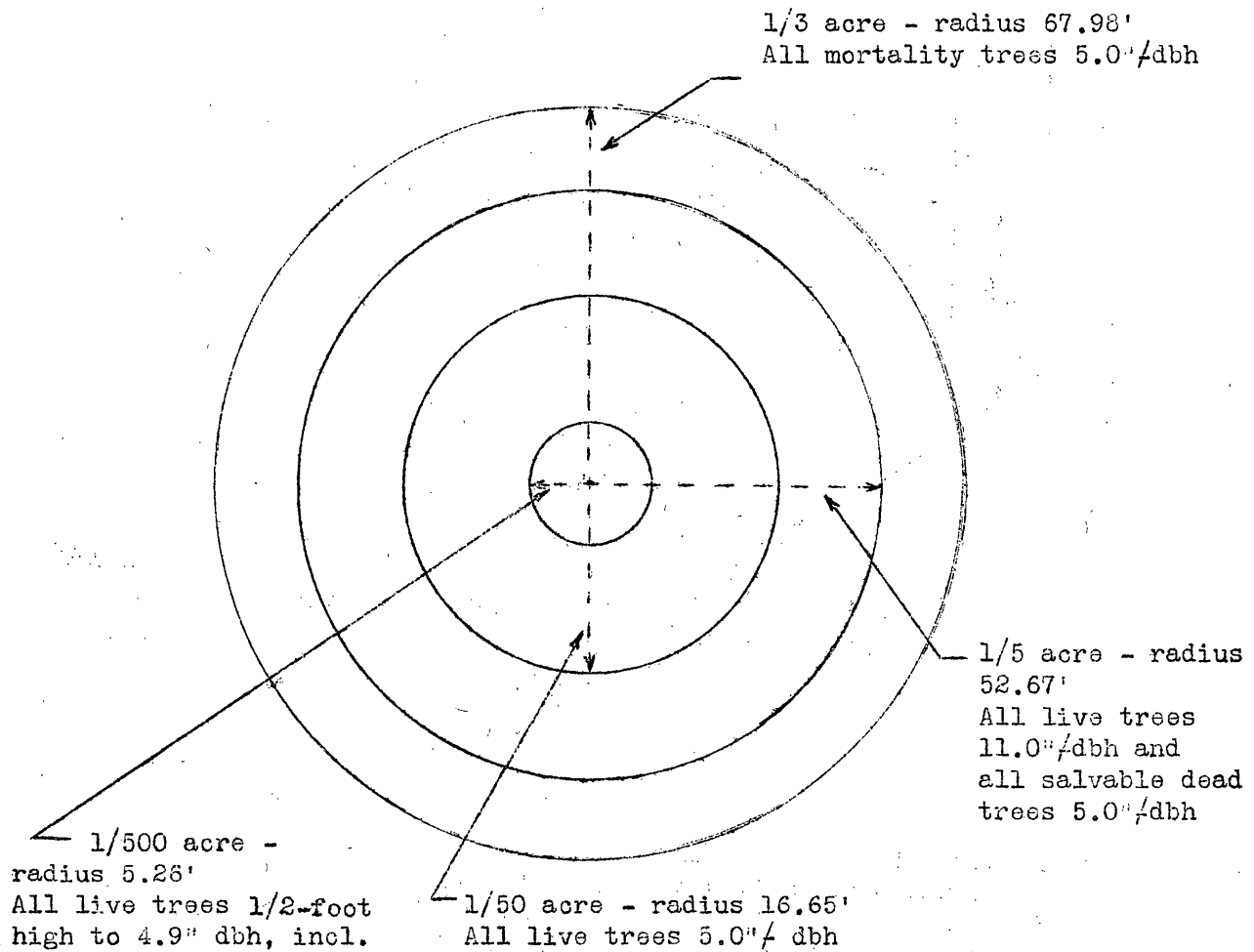


DIAGRAM SHOWING METHOD OF DETERMINING BREAST HIGH
POINT AND CORRECTING PLOT RADII FOR SLOPE

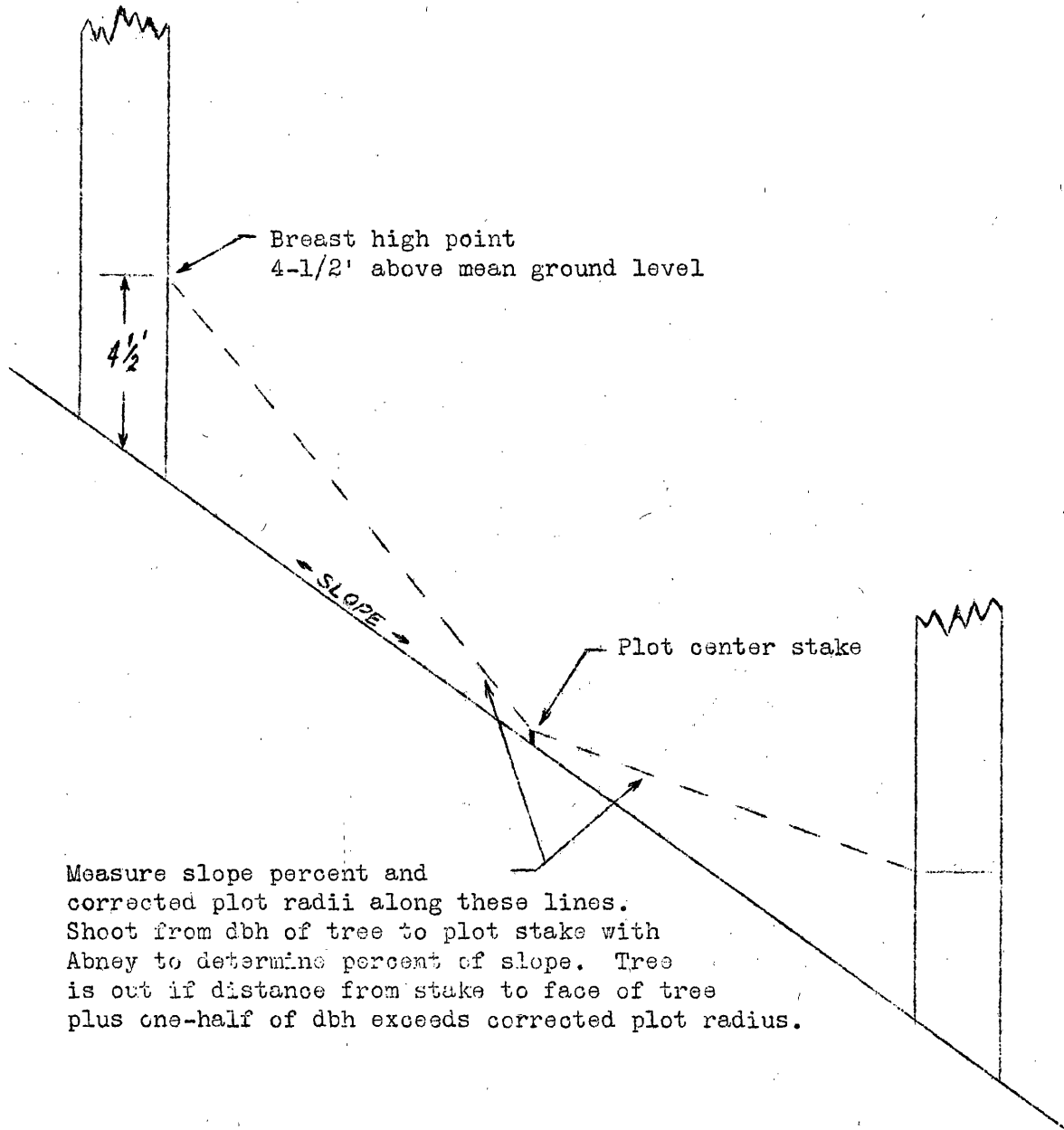
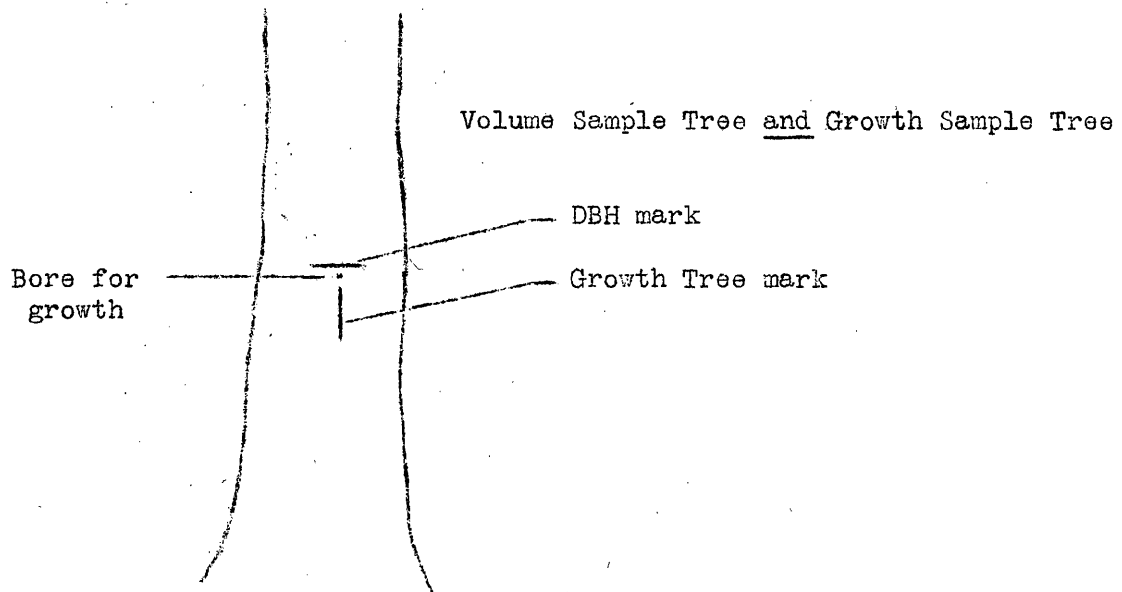
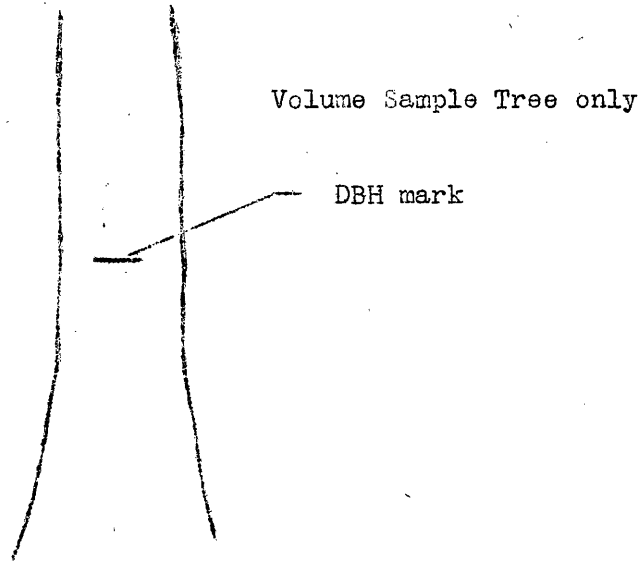


DIAGRAM OF METHOD OF MARKING VOLUME SAMPLE
AND GROWTH SAMPLE TREES

All marks on side facing plot center



GUIDES FOR ESTIMATING TIME SINCE MORTALITY

Died within past 5 years	Species	Died more than 5 years ago
Some foliage remaining 75% or more of twigs remaining 30% or more of branches remaining Bark intact	White pine	No foliage Less than 75% of twigs remaining Numerous large limbs falling Considerable bark sloughing (except small trees)
Some foliage remaining 50% or more of twigs remaining Nearly all branches remaining Bark nearly all present	Ponderosa pine	No foliage Large limbs falling Considerable bark sloughing Less than 50% of branches and twigs remaining
Some foliage remaining 30% or more of twigs remaining 50% or more of branches remaining Little sloughing of bark	Spruce	No foliage Less than 50% of branches remaining Large limbs falling Less than 30% of twigs remaining Considerable bark sloughing
Some foliage remaining 75% or more of twigs remaining 75% or more of branches remaining	Lodgepole pine	No foliage Less than 75% of twigs or branches remaining Bark sloughing
Some foliage remaining 50% or more of twigs remaining 75% or more of branches remaining Bark intact	Douglas-fir	No foliage Less than 50% of twigs or 75% of branches remaining Large limbs falling Bark sloughing (except very young trees)
Some foliage remaining 50% or more of twigs remaining 75% or more of branches remaining Smooth bark unbroken, not curled away from bole	True firs	No foliage Less than 50% of twigs remaining Less than 75% of branches remaining Large limbs falling Smooth bark extensively checked and curled, considerable sloughing
50% or more of bark still attached in some degree to bole	Aspen	No foliage Bark fallen completely free of bole, or less than 50% attached in any degree
Some foliage remaining 60% or more of twigs remaining Few limbs falling Bark intact	Western red-cedar	No foliage Less than 60% of twigs remaining Some limbs falling Large pieces of bark stripping

In all cases the presence of sporophores of sapwood-rotting fungi such as Polyporus volvatus, Fomes pinicola, etc., will be accepted as evidence that the tree has been dead more than 5 years.

GUIDES FOR ESTIMATING LOG GRADES

All logs of sawtimber sample trees, all species, are to be graded by the following rules:

a. Grade 1 - Select logs are essentially smooth and surface clear, except that in logs 16 inches and over in diameter a few visible knots are permitted, provided there are no more than one large knot, or two medium or small knots, or four pin knots.

NOTE: Knot sizes for all grades are:

Pin knots	1/2 inch or less
Small knots	1/2 - 3/4 inch
Medium knots	3/4 - 1-1/2 inches
Large knots	Over 1-1/2 inches

Occasional logs having a greater number of knots are admitted, provided these knots may be boxed in an area not exceeding one-third the area of one face or an equivalent area on two faces.

b. Grade 2 - Shop logs display relatively few knots of any size, so spaced that at least 50 percent of the surface of the log is in smooth, clear areas, the size of which must be at least one-fourth the girth of the log in width by 4 feet or more in length.

NOTE: If a log has no more than 12 medium or smaller knots nor more than 8 large ones, it may be immediately classed as Grade 2. If this number of knots is exceeded, the clear-area basis shall govern.

c. Grade 3 - Common logs display either (a) numerous pin, small, or medium knots of which 80 percent are either live or will cut out red (intergrown) beneath the slab^{3/} or (b) 16 dead knots (an average of 4 per face) averaging medium in size.

d. Grade 4 - Low common logs display medium, large, and very large live and/or dead knots in excess of the numbers permitted in grades 2 and 3.

The above log grade specifications are based on "Grading of logs and trees as a means of measuring quality," by I. V. Anderson, Northern Rocky Mountain Forest and Range Experiment Station, mimeographed paper, 23 pages, April 1939.

3/ A knot will usually cut out red beneath the slab if it is recently dead as evidenced by the fact that the bark has not become loosened from the branch, and if the stubs do not show pronounced checking. This guide to the character of a knot is recommended unless there is definite local information which is contradictory.

IBM CODES FOR DATA TO BE ENTERED ON SAMPLE PLOT RECORD

Bark Thickness. Recorded on the Sample Plot Record for all Growth Trees as a 3-digit code like 010, 050, 105, etc.

Cause of Death (CD). Recorded as a single-digit code on the Sample Plot Record for each Mortality Tree. Code is printed on Sample Plot Record for Live Trees and Salvable Dead Trees. The cause of death codes are:

0 Live Trees	5 Weather
1 Insects	6 Animal
2 Disease	8 Salvable Trees
3 Fire	
4 Other	

County. Recorded as a 2-digit code on the Record of Area and the Sample Plot Record. The county codes by states are:

03 - Arizona

01 Apache	06 Greenlee	11 Pinal
02 Cochise	07 Maricopa	12 Santa Cruz
03 Coconino	08 Mohave	13 Yavapai
04 Gila	09 Navajo	14 Yuma
05 Graham	10 Pima	

06 - Colorado

01 Adams	22 Fremont	43 Montrose
02 Alamosa	23 Garfield	44 Morgan
03 Arapahoe	24 Gilpin	45 Otero
04 Archuleta	25 Grand	46 Ouray
05 Baca	26 Gunnison	47 Park
06 Bent	27 Hinsdale	48 Phillips
07 Boulder	28 Huerfano	49 Pitkin
08 Chaffee	29 Jackson	50 Prowers
09 Cheyenne	30 Jefferson	51 Pueblo
10 Clear Creek	31 Kiowa	52 Rio Blanco
11 Conejos	32 Kit Carson	53 Rio Grande
12 Costilla	33 Lake	54 Routt
13 Crowley	34 La Plata	55 Saguache
14 Custer	35 Larimer	56 San Juan
15 Delta	36 Las Animas	57 San Miguel
16 Denver	37 Lincoln	58 Sedgwick
17 Dolores	38 Logan	59 Summit
18 Douglas	39 Mesa	60 Teller
19 Eagle	40 Mineral	61 Washington
20 Elbert	41 Moffat	62 Weld
21 El Paso	42 Montezuma	63 Yuma

13 - Idaho

01 Ada
02 Adams
03 Bannock
04 Bear Lake
05 Benewah
06 Bingham
07 Blaine
08 Boise
09 Bonner
10 Bonneville
11 Boundary
12 Butte
13 Camas
14 Canyon
15 Caribou

16 Cassia
17 Clark
18 Clearwater
19 Custer
20 Elmore
21 Franklin
22 Fremont
23 Gem
24 Gooding
25 Idaho
26 Jefferson
27 Jerome
28 Kootenai
29 Latah
30 Lemhi

31 Lewis
32 Lincoln
33 Madison
34 Minidoka
35 Nez Perce
36 Oneida
37 Owyhee
38 Payette
39 Power
40 Shoshone
41 Teton
42 Twin Falls
43 Valley
44 Washington
57 Yellowstone National
Park

27 - Montana

01 Beaverhead
02 Big Horn
03 Blaine
04 Broadwater
05 Carbon
06 Carter
07 Cascade
08 Chouteau
09 Custer
10 Daniels
11 Dawson
12 Deer Lodge
13 Fallon
14 Fergus
15 Flathead
16 Gallatin
17 Garfield
18 Glacier
19 Golden Valley

20 Granite
21 Hill
22 Jefferson
23 Judith Basin
24 Lake
25 Lewis and Clark
26 Liberty
27 Lincoln
28 McCone
29 Madison
30 Meagher
31 Mineral
32 Missoula
33 Musselshell
34 Park
35 Petroleum
36 Phillips
37 Pondera
38 Powder River

39 Powell
40 Prairie
41 Ravalli
42 Richland
43 Roosevelt
44 Rosebud
45 Sanders
46 Sheridan
47 Silver Bow
48 Stillwater
49 Sweet Grass
50 Teton
51 Toole
52 Treasure
53 Valley
54 Wheatland
55 Wibaux
56 Yellowstone
57 Yellowstone National
Park

29 - Nevada

01 Churchill
02 Clark
03 Douglas
04 Elko
05 Esmeralda
06 Eureka

07 Humboldt
08 Lander
09 Lincoln
10 Lyons
11 Mineral
12 Nye

13 Ormsby
14 Pershing
15 Storey
16 Washoe
17 White Pine

32 - New Mexico

01 Bernalillo	11 Harding	22 Sandoval
02 Catron	12 Hidalgo	23 San Juan
03 Chaves	13 Lea	24 San Miguel
04 Colfax	14 Lincoln	25 Santa Fe
05 Curry	15 Luna	26 Sierra
06 De Baca	16 McKinley	27 Socorro
07 Dona Ana	17 Mora	28 Taos
08 Eddy	18 Otero	29 Torrance
09 Grant	19 Quay	30 Union
10 Guadalupe	20 Rio Arriba	31 Valencia
	21 Roosevelt	

42 - South Dakota

01 Armstrong	24 Fall River	47 Meade
02 Aurora	25 Faulk	48 Mellette
03 Beadle	26 Grant	49 Miner
04 Bennett	27 Gregory	50 Minnehaha
05 Bon Homme	28 Haakon	51 Moody
06 Brookings	29 Hamlin	52 Pennington
07 Brown	30 Hand	53 Perkins
08 Brule	31 Hanson	54 Potter
09 Buffalo	32 Harding	55 Roberts
10 Butte	33 Hughes	56 Sanborn
11 Campbell	34 Hutchinson	57 Shannon
12 Charles Mix	35 Hyde	58 Spink
13 Clark	36 Jackson	59 Stanley
14 Clay	37 Jerauld	60 Sully
15 Codington	38 Jones	61 Todd
16 Corson	39 Kingsbury	62 Tripp
17 Custer	40 Lake	63 Turner
18 Davison	41 Lawrence	64 Union
19 Day	42 Lincoln	65 Walworth
20 Deuel	43 Lyman	66 Washabaugh
21 Dewey	44 McCook	67 Washington
22 Douglas	45 McPherson	68 Yankton
23 Edmunds	46 Marshall	69 Ziebach

45 - Utah

01 Beaver	11 Iron	21 Sevier
02 Box Elder	12 Juab	22 Summit
03 Cache	13 Kane	23 Tooele
04 Carbon	14 Millard	24 Uintah
05 Daggett	15 Morgan	25 Utah
06 Davis	16 Piute	26 Wasatch
07 Duchesne	17 Rich	27 Washington
08 Emery	18 Salt Lake	28 Wayne
09 Garfield	19 San Juan	29 Weber
10 Grand	20 Sanpete	

51 - Wyoming

01 Albany	09 Hot Springs	17 Sheridan
02 Big Horn	10 Johnson	18 Sublette
03 Campbell	11 Laramie	19 Sweetwater
04 Carbon	12 Lincoln	20 Teton
05 Converse	13 Natrona	21 Uinta
06 Crook	14 Niobrara	22 Washakie
07 Fremont	15 Park	23 Weston
08 Goshen	16 Platte	57 Yellowstone National Park

DBH - 1/10 inch. Recorded as a 3-digit number on the Sample Plot Record for all live trees except seedling-sapling trees on all plots like 068, 175, 200, etc.

DBH - 2-inch class. Recorded as a 3-digit code on the Sample Plot Record for Mortality and Salvable Dead Trees on all plots like 100, 060, 160, etc. The 2-inch DBH classes by 1/10-inch diameter groups are the same as set up for INT:

080	7.0" - 8.9"
100	9.0" - 10.9"
120	11.0" - 12.9"

etc.

Defect Percent, Board Feet and Cubic Feet. Recorded as a 2-digit code on the Sample Plot Record for all live sawtimber trees, like 07, 10, 23, 49, 84, etc. The code 00 is used for each merchantable tree with no defect.

Height in Feet. Recorded as a 3-digit code on the Sample Plot Record for all trees, except seedling-sapling trees, on all plots, like 065, 073, 105, etc. Height in feet is not determined for Seedling-Sapling Trees and the code 000 is printed on the Sample Plot Record for these trees.

Height in Logs. Recorded as a 1-digit code on the Sample Plot Record for all trees like 0, 1, 3, etc. Log height is coded 0 for Pole Trees and Cull Sawtimber Trees. The log height code is printed on the Sample Plot Record for Mortality, Salvable Dead, and Seedling-Sapling Trees.

Location Number. Recorded on Sample Plot Record as a 3-digit code like 001, 010, 103, etc. The location number is the number assigned to each sample section and/or volume sample plot cluster. (See Plot Number)

Log Grade. Recorded as a single-digit code on the Sample Plot Record for each log in each growth tree, beginning with the butt log as No. 1. If a growth tree has no logs, a horizontal line is drawn through the log grade columns.

A log grade code must be entered for each log in the tree, including cull logs and logs no longer in existence because of broken or missing tops. The code 0 is entered in the proper log position for cull logs and missing logs.

Trees that fork at or below DBH are treated as two trees with log grades recorded for each stem. Trees that fork above DBH are treated as one tree with log grades recorded for the longest stem.

Live trees that are not Growth Trees do not have log grade coded for them. A horizontal line is drawn in the log grade column for these trees.

The log grade codes are:

- | | |
|------------------------------|---------------|
| 1 Log grade 1 | 4 Log grade 4 |
| 2 Log grade 2 | 5 Log grade 5 |
| 3 Log grade 3 | 6 Log grade 6 |
| 0 Cull logs and missing logs | |

Merchantability Class (MC). Recorded on Sample Plot Record for each tree as a 1-digit code. Merchantability class codes are:

- | | |
|---|--------------------------------------|
| 1 Merchantable trees | 6 |
| 2 Sound cull trees | 7 Mortality trees |
| 3 Rotten cull trees | 8 Salvable dead trees suitable for |
| 4 | lumber |
| 5 | 9 No live inventory tree on the plot |
| 0 Salvable dead trees suitable for other uses | |

Merchantability class codes are printed on the Sample Plot Record for Mortality and Seedling-Sapling Trees.

Number of Trees. Recorded on the Sample Plot Record as a 2-digit code for Seedling-Sapling Trees by class and Salvable Dead Trees like 01, 03, 11, etc.

Number of trees code is printed on Sample Plot Record for Live Inventory and Mortality Trees.

Ownership. Recorded on Sample Plot Record as 2-digit code like 07, 11, etc. The ownership codes are:

Federal

- 01 National forests - unreserved
- 02 National parks and monuments
- 03 Indian lands
- 04 Bureau of Land Management
- 06 Other Federal
- 07 National forest - reserved
- 08 Other Federal - reserved

State

- 11 State - unreserved
- 17 State - reserved

County and Municipal

- 21 County and municipal - unreserved
- 27 County and municipal - reserved

Private

- 31 Industrial
- 32 Other private
- 41 Farm

Unknown

- 99 Any area where ownership is not known or classified

Plot Number. Recorded on the Sample Plot Record as single-digit code following (and separated by a dash from) the Location Number Code. The Plot Number is the number of each of the two individual volume plots at a location which are numbered 1 and 2. The complete location-plot number code is recorded like 001-1, 001-2; 103-1, 103-2, etc.

Plot Size. Recorded on Sample Plot Record for each Inventory Tree as a single-digit code. The Plot Size codes are:

- | | |
|--------------|-----------------------------------|
| 1 1/500-acre | 4 1/3-acre |
| 2 1/50-acre | 5 Trees 11.0" / dbh on 1/50-acre |
| 3 1/5-acre | 9 No live inventory trees on plot |

The plot size codes for Mortality, Salvable Dead, and Seedling-Sapling Trees are printed on the Sample Plot Record in the section heading.

Radial Growth, 0-5 years and 0-10 years. Recorded on the Sample Plot Record for each Growth Tree, separately for 0-5 years and 0-10 years as a 3-digit code like 010, 025, 105, etc.

Sampling Unit and Subunit. Recorded on Sample Plot Record as 2-digit code for Sampling Unit and 1-digit code for Subunit.

Sampling Unit and Subunit codes are: (Subunits ranging in number from 1 to 5 per sampling unit to be added under each forest when supplied by Regions 1, 2, and 4.)

06 - Colorado

- | | |
|---------------|---------------------------|
| 20 Arapaho | 26 San Isabel |
| 21 Gunnison | 27 San Juan |
| 22 Pike | 28 Grand Mesa-Uncompahgre |
| 23 Rio Grande | 29 White River |
| 24 Roosevelt | 91 X(11) Western Colorado |
| 25 Routt | 92 R(12) Eastern Colorado |

13 - Idaho

- | | |
|------------------|-------------|
| 11 Bitterroot | 41 Boise |
| 12 Clearwater | 42 Cache |
| 13 Coeur d'Alene | 43 Caribou |
| 14 Kaniksu | 44 Payette |
| 15 Kootenai | 45 Salmon |
| 16 Lolo | 46 Sawtooth |
| 17 Nez Perce | 47 Targhee |
| 18 Lolo | |

27 - Montana

09	Beaverhead	15	Helena
10	Bitterroot	16	Kaniksu
11	Custer	17	Kootenai
12	Deerlodge	18	Lewis and Clark
13	Flathead	19	Lolo
14	Gallatin		

29 - Nevada

41	Humboldt	43	Toiyabe
42	Nevada		

42 - South Dakota

11	Custer	21	Black Hills
----	--------	----	-------------

45 - Utah

41	Ashley	46	Manti-laSal
42	Cache	47	Sawtooth
43	Caribou	48	Uinta
44	Dixie	49	Wasatch
45	Fishlake		

48 - Washington

11	Colville	12	Kaniksu
----	----------	----	---------

51 - Wyoming

21	Big Horn	41	Bridger
22	Black Hills	42	Caribou
23	Medicine Bow	43	Targhee
24	Shoshone	44	Teton
		45	Wasatch

Seedling-Sapling Tree Class. Recorded as a 3-digit code for seedling-sapling trees. The seedling-sapling tree class codes are:

010 1/2 foot high to 0.99" dbh
020 1.0" - 2.99" dbh
040 3.0" - 4.99" dbh

Species. Recorded on the Sample Plot Record for each tree as a 2-digit code like 01, 11, 41, etc. The species codes are:

1 - Conifers

- 01 Douglas-fir
- 11 Ponderosa pine
- 14 Western white pine
- 15 Lodgepole pine
- 26 Whitebark, limber, and bristlecone pine
- 27 Pinyon pine
- 31 White fir
- 33 Grand fir
- 36 Alpine and corkbark fir
- 41 Spruce
- 47 Mountain hemlock
- 48 Western hemlock
- 49 Dead spruce
- 54 Western redcedar
- 55 Western larch
- 63 Juniper

3 - Hardwoods

- 70 Other hardwoods
- 73 Aspen
- 75 Cottonwood

Stand-Size Class. Recorded on the Sample Plot Record as a single-digit code like 1, 2, etc. The stand-size class codes are:

- 1 Large sawtimber (21.0" / dbh)
- 2 Small sawtimber (11.0" - 20.99" dbh)
- 3 Poletimber (5.0" - 10.99" dbh)
- 4 Seedling-sapling (1/2 foot high - 4.99" dbh)
- 5 Nonstocked and deforested
- 9 Not classified--used with Dead Spruce stands

State. Recorded on the Sample Plot Record as a 2-digit code like 06, 13, 27, etc. The state codes are:

- | | |
|-------------|-----------------|
| 03 Arizona | 32 New Mexico |
| 06 Colorado | 42 South Dakota |
| 13 Idaho | 45 Utah |
| 27 Montana | 51 Wyoming |
| 29 Nevada | |

Stocking Class (Crown Density). A dual classification is used for sawtimber stands, all trees and sawtimber trees in that order, and a single classification, all trees, for pole and seedling-sapling stands. The codes are:

- | | | |
|---|----------------|--|
| 1 | Well stocked | 70% + crown closure |
| 2 | Medium stocked | 40 - 69% crown closure |
| 3 | Poorly stocked | 10 - 39% crown closure |
| 5 | | 0 - 9% crown closure. Used for second density code for pole and seedling-sapling stands and for both density codes for nonstocked stands |
| 9 | Not classified | Used for Dead Spruce |

Type, Forest and Cover. Recorded on the Sample Plot Record as a 2-digit code like 01, 11, 41, 33, etc. The forest and cover type codes are:

Commercial forest

1 - Conifers

Map Symbol

D	01	Douglas-fir
P	11	Ponderosa pine
WP	14	Western white pine
LP	15	Lodgepole pine
WLP	26	Whitebark, limber, and bristlecone pine
WF	31	White fir
GF	33	Grand fir
AF	36	Alpine and corkbark fir

Map Symbol

S	41	Spruce
MH	47	Mountain hemlock
WH	48	Western hemlock
DS	49	Dead spruce
C	54	Western redcedar
L	55	Western larch

3 - Hardwoods

OH	70	Other hardwoods
A	73	Aspen
Co	75	Cottonwood

Noncommercial forest

Map Symbol

NA	60	Aspen
NPJ	63	Pinyon-juniper
NC	65	Chaparral
NO	66	Other

Nonforest

W	81	Water areas under 40 acres
NF	82	Other nonforest

(No plots will be taken in noncommercial or nonforest types.)

SAMPLE PLOT RECORD

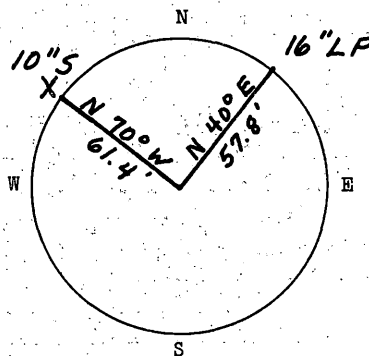
Photo Numbers DLT 6 41-43
Sec. 17 Twp. 2 S Rge. 89 W
Elevation 8700
Site Tree:Sp. S Dbh. 13.4 Ht. 68 Age 124
Recorder Jones
Estimator Jackson
Date 7/17/55

101

MORTALITY								SALVABLE DEAD								SEEDLING-SAPLING							
Plot Size = 1/3 Acre Code 4								Plot Size = 1/5 Acre Code 3								Plot Size = 1/500 Acre Code 1							
Spe- cies xx	2" DBH Class xxx	Total Ht. (ft.) xxx	MC x	Log Ht. x	CD x	No. of Trees xx	YD	Spe- cies xx	2" DBH Class xxx	Total Ht. (ft.) xxx	MC x	Log Ht. x	CD x	No. of Trees xx	Spe- cies xx	Class xxx	Total Ht. xxx	MC x	Log Ht. x	CD x	No. of Trees xx		
41	080	045	7	0	1	01	52	41	080	045	0	0	8	01	41	010	000	1	0	0	02		
41	140	065	7	0	3	01	55	15	140	065	8	0	8	02	41	020	000	1	0	0	01		
15	120	060	7	0	2	01	54	41	140	065	0	0	8	01	15	040	000	1	0	0	01		
			7	0		01		41	100	055	0	0	8	03			000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0		01						0	8				000	1	0	0			
			7	0																			

Plot Radii
 1/3 Acre 67.98'
 1/5 Acre 52.67'
 1/10 Acre 37.24'
 1/50 Acre 16.65'
 1/500 Acre 5.26'

Plot Sketch
 (Plot bearing and distance
 to two witness trees)



Reference Point
 (Description and how to reach)

Follow Smith Creek road to
 trail up Alder Gulch. Go up
 this trail approximately
 75 chains to top of ridge,
 and go east along ridge
 approximately 25 chains
 to clump of aspen. RP
 is 24" DF on west edge
 of clump.

RP or ~~center~~ to Plot 1:
 Brg N 74° W Dist 4 1/2 ch.

Plot 1 to Plot 2:
 Brg North Dist 5 ch.

SLOPE DISTANCES - PLOT RADII				
Percent slope	1/3 acre	1/5 acre	1/50 acre	1/500 acre
0	67.98	52.67	16.65	5.26
2	68.0	52.7		
4	68.0	52.7	16.7	
6	68.1	52.7		
8	68.2	52.8		
10	68.3	52.9		5.30
12	68.5	53.0	16.8	
14	68.6	53.2		
16	68.8	53.3	16.9	
18	69.1	53.5		
20	69.3	53.7	17.0	5.37
22	69.6	53.9		
24	69.9	54.2	17.1	
26	70.2	54.4	17.2	
28	70.6	54.7	17.3	
30	71.0	55.0	17.4	5.50
32	71.4	55.3	17.5	
34	71.8	55.6	17.6	
36	72.2	56.0	17.7	
38	72.7	56.3	17.8	
40	73.2	56.7	17.9	5.68
42	73.7	57.1	18.1	
44	74.3	57.5	18.2	
46	74.8	58.0	18.3	
48	75.4	58.4	18.5	
50	76.0	58.9	18.6	5.89
52	76.6	59.4	18.8	
54	77.3	59.8	18.9	
56	77.9	60.4	19.1	
58	78.6	60.9	19.2	
60	79.3	61.4	19.4	6.15
62	80.0	62.0	19.6	
64	80.7	62.5	19.8	
66	81.4	63.1	19.9	
68	82.2	63.7	20.1	
70	83.0	64.3	20.3	6.43
72	83.8	64.9	20.5	
74	84.6	65.5	20.7	
76	85.4	66.1	20.9	
78	86.2	66.8	21.1	
80	87.1	67.4	21.3	6.75
82	87.9	68.1	21.5	
84	88.8	68.8	21.8	
86	89.7	69.5	22.0	
88	90.6	70.2	22.2	
90	91.5	70.9	22.4	7.09
92	92.4	71.6	22.6	
94	93.3	72.3	22.8	
96	94.2	73.0	23.1	
98	95.2	73.7	23.3	
100	96.1	74.5	23.6	7.45

ADJUSTMENT OF PHOTO SCALE FOR ELEVATION DIFFERENCE			
Change from datum plane	8.25 inches	6 inches	5.25 inches
	6875-feet	5000-feet	4375-feet
	Change in photo scale (R.F.)		
Feet	Units		
+ 7000	- 7000	-10000	-12000
+10000	-15000	-20000	-24000
+15000	-22000	-30000	-35000
+20000	-29000	-40000	-47000
+25000	-36000	-50000	-59000
+30000	-44000	-60000	-71000
+35000	-51000	-70000	-82000
+40000	-58000	-80000	-94000
+45000	-65000	-90000	-106000
+50000	-73000	-100000	-118000
Scale changes rounded to nearest 100 units.			
To use: Determine scale at selected datum plane. Above datum plane, change is minus.			
Below datum plane change is plus.			

ADJUSTMENT OF CHAINAGE FOR SCALE DIFFERENCE									
RF in thou-	1	2	3	4	5	6	7	8	9
sands	Distance converted to R/F of photo (chains)								
1:15	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75
16	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20
17	0.85	1.70	2.55	3.40	4.25	5.10	5.95	6.80	7.65
18	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10
19	0.95	1.90	2.85	3.80	4.75	5.70	6.65	7.60	8.55
20	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
21	1.05	2.10	3.15	4.20	5.25	6.30	7.35	8.40	9.45
22	1.10	2.20	3.30	4.40	5.50	6.60	7.70	8.80	9.90
23	1.15	2.30	3.45	4.60	5.75	6.90	8.05	9.20	10.35
24	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.80
25	1.25	2.50	3.75	5.00	6.25	7.50	8.75	10.00	11.25
26	1.30	2.60	3.90	5.20	6.50	7.80	9.10	10.40	11.70
27	1.35	2.70	4.05	5.40	6.75	8.10	9.45	10.80	12.05
28	1.40	2.80	4.20	5.60	7.00	8.40	9.80	11.20	12.60
29	1.45	2.90	4.35	5.80	7.25	8.70	10.15	11.60	13.05
30	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50
31	1.55	3.10	4.65	6.20	7.75	9.30	10.85	12.40	14.05
32	1.60	3.20	4.80	6.40	8.00	9.60	11.20	12.80	14.40

FOREST COVER TYPE		
Code	Commercial Forest (Includes productive noncommercial)	Symbol
01	Douglas-fir	D
11	Ponderosa pine	P
14	Western white pine	WP
15	Lodgepole pine	LP
26	Whitebark, limber, and bristle-cone pine	WLP
31	White fir	WF
33	Grand fir	GF
36	Alpine and corkbark fir	AF
41	Spruce	S
47	Mountain hemlock	MH
48	Western hemlock	WH
49	Dead spruce	DS
54	Western redcedar	C
55	Western larch	L
70	Other hardwood	OH
73	Aspen	A
75	Cottonwood	Co
Noncommercial Forest		
60	Aspen	NA
63	Pinyon-juniper	NPJ
65	Chaparral	NC
66	Other	NO
Nonforest		
81	Water - Under 40 acres	W
82	Other nonforest	NF

STAND-SIZE CLASS		
1	Large sawtimber (21.0" / dbh)	9B
2	Small sawtimber (11.0"-20.99" dbh)	9A
3	Poletimber (5.0"-10.99" dbh)	8
4	Seedling-sapling (1/2'-4.99" dbh)	7
5	Nonstocked and deforested	6

CROWN DENSITY CLASS		
1	70% / crown closure	W
2	40 - 69% crown closure	M
3	10 - 39% crown closure	P
5	Not classified	

SAMPLE MAP SYMBOLS (and Codes)	
P9A WM	Ponderosa pine type, small saw-(11 2 12) timber, well stocked by all crowns, medium stocked by sawtimber crowns.
D 8 M	Douglas-fir type, poletimber stand, (01 3 25) medium stocked by all crowns.
P 6	Ponderosa pine type, deforested. (11 5 55)
NPJ	Noncommercial unproductive forest land, pinyon-juniper type.

TREE SIZE	
Seedling-sapling	1/2-foot high to 4.99" dbh
Poles - dbh	5.0" - 10.99"
Sawtimber - dbh	11.0" /

MERCHANTABLE TOP DIB	
DBH Class	Top DIB (Inches)
10 - 11"	5
12 - 15"	6
16 - 18"	7
19 - 21"	8
22 - 25"	9
26 /	10
(Based on definition: Top dib = .3dbh / 2.0")	

MINIMUM NUMBER S&S TREES ON 1/500 ACRE BY STOCKING CLASS			
S&S Class	Stocking Class		
	W	M	P
010	5	3	1
020	3	2	1
040	2	1	-

SPECIES CODE	
01	Douglas-fir
11	Ponderosa pine
14	Western white pine
15	Lodgepole pine
26	Whitebark, limber, and bristle-cone pine
27	Pinyon pine
31	White fir
33	Grand fir
36	Alpine and corkbark fir
41	Engelmann spruce
44	White spruce
45	Blue spruce
47	Mountain hemlock
48	Western hemlock
54	Western redcedar
55	Western larch
56	Alpine larch
63	Juniper
70	Other hardwood
73	Aspen
75	Cottonwood

PLOT SIZE CODE	
1	1/500 acre - Seedling-sapling trees
2	1/50 acre - Pole trees
3	1/5 acre - Sawtimber and salvageable dead trees
4	1/3 acre - Mortality trees
5	1/50 acre - Sawtimber trees (11.0" dbh)

MERCHANTABILITY CLASS CODE (MC)	
1	Merchantable tree
2	Sound cull tree
3	Rotten cull tree
7	Mortality tree
8	Salvage tree - lumber
0	Salvage tree - other

CAUSE OF DEATH CODE			
1	Insects	4	Other
2	Disease	5	Weather
3	Fire	6	Animal

SEEDLING-SAPLING TREE CODE	
010	1/2' high through 0.99" dbh
020	1.0" dbh through 2.99" dbh
040	3.0" through 4.99" dbh

LOG GRADE CODE		
Code	Grade	Description
1	Select	Surface clear
2	Shop	Few knots, 50% surface clear
3	Common	Numerous pin, small, or medium live knots
4	Low common	Medium, large, and very large live or dead knots
0	Cull and missing logs	

OWNERSHIP CLASS CODE	
01	National forest - Unreserved
02	National parks and monuments
03	Indian lands
04	Bureau of Land Management
06	Other Federal
07	National forest - Reserved
08	Other Federal - Reserved
11	State - Unreserved
17	State - Reserved
21	County and municipal - Unreserved
27	County and municipal - Reserved
31	Private - Industrial
32	Private - Other
41	Private - Farm
51	Private - Reserved
99	Unknown

FOREST SURVEY
I.F. & R.E.S.
Ogden, Utah
1956

APPENDIX B

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ADMINISTRATIVE INSTRUCTIONS

Time Reports

Form FS-26 will be used to record time worked and leave taken. Do not make any computations on this form. Mail the signed time reports to Ogden on the evening of the last work day of the pay period. Promptness is necessary so that your name can be included on the payroll.

If you should be called for firefighting on one of the national forests, show all firefighting time on a separate line on Form 26. In the Function block show name and class of fire. This information can be obtained from the person in charge of the fire camp. Show name of forest on which fire occurred. A Form FS 874-15A showing a record of your time on the fire should be obtained from the person assigning you to the fire and attached to your Form FS-26.

If you are called on a fire after having mailed in your time report for the period, request that a record of your fire time be sent promptly to the Intermountain Station on Form FS 874-15A by the forest officer assigning you to the fire.

Travel Expenses

Per diem accounts are paid on a monthly basis. The signed, completed expense accounts on Form 1012 (original) and 1012a (carbon copy) should be mailed promptly at the end of each month as the accounts cannot be paid until they are received. The accounts should be prepared in the field in ink, indelible pencil, or type-written and the original must be signed and dated. The accounts must be accompanied by the diary sheets for the period covered by

the expense account, and should agree with the diary entries as to dates and hours of departures from and arrivals at official stations and field headquarters, and cash disbursements for official purposes.

A signed receipt is required for expenditures of \$3.00 or more.

Fill in all required items. If in travel status at the end of the month, the account should state "In field at (location) end of account." The next account would then show "In field at (location) beginning of account."

Be sure to show method of transportation. If by Government auto give the car number. If by common carrier, fill in required information, including transportation request numbers and attach white copy of TR to expense account.

Whenever you return to your official headquarters, times of arrival and departure must be shown even though you are there only during nonwork hours.

Motor Vehicles

Each Forest Survey car is equipped with credit cards under present contracts (new cards will be sent you July 1), purchase order book Form AD-128 or SF 44, Accident Report Standard Form 91, and Statement of Witness Standard Form 94.

Credit cards cover the furnishing of lubricating services, including transmission and differential, wheel packing, oil filter elements, battery service, tire and tube repair, cleaning of air or other filters, washing of vehicles, emergency replacement of burned-out light bulbs and sealed beam headlight units. They do not cover the furnishing of parking space, tires, tubes, batteries, automobile

accessories, or repairs other than those known in the automobile trade as "road repairs."

Only the regular or nonpremium grade of gasoline should be purchased for Government cars. The lubricating oil may be the regular non-premium or the premium.

Antifreeze should be purchased at a service station only in emergency.

Service station tickets and purchase orders should be accumulated and sent in biweekly with your time report. All service station tickets must show car license number.

Rented cars will use credit cards furnished by the rental agency. Service station tickets and purchase orders will be sent to the rental agency.

A mileage book will be kept in each vehicle and daily entries will be made showing date, mileage traveled, starting and ending points, and driver.

Enter car repairs or maintenance on back of current mileage book sheet along with the mileage and date when repairs and maintenance were made.

Every accident must be reported except those minor ones occurring in the camp area or on work projects which do not involve personal injury or private property damage, and where the damage to Government cars is of minor nature such as bent fender or bumper, dented body. Fill out Standard Form 91 before you move the car. Notify your supervising officer immediately. Statements from witnesses on Standard Form 94 should be obtained on the spot.

Purchase Order Book

Form AD-128 or Standard Form 44 (field purchase order) will be used for all purchases other than credit card purchases or small cash purchases--\$3.00 or less--to be claimed on an expense account. The sales ticket must be attached to the purchase order.

Use ink or indelible pencil in preparation. The firm name and payee lines should be exactly the same. Have the payee sign the original at the bottom. Give the first carbon to the vendor and send the original and second carbon to Ogden. Be sure the second carbon copy has date of receipt and signature.

Batteries, tires, and spark plugs can be purchased in the field only in an emergency. Attach memorandum to purchase order, giving complete statement of emergency.

Be sure to show the car number if the purchase order is used to purchase car repairs. If the repair is not a "package job" but consists of a separate charge for parts and labor, these must be listed separately on the purchase order.

Send purchase orders in biweekly with your time reports.

Field purchase orders issued for pack horse service should be supported by contracts showing the liability of the Government for horses and equipment, and must show period of service. Use Form 587 "Equipment Agreement," for this purpose. Fieldmen should anticipate the need for hiring pack stock at least one pay period in advance and check with the Ogden office as to proper procedures and forms to be used.

Personal Injury

Every injury should be reported on Form C.A. 1. Make out the report at the time of injury, even though it was not serious enough to disable you for work. Notify your supervising officer immediately if medical attention is needed.

Division Reports

One copy of the "Biweekly Field Progress Report," Form 26 Rev. 2 should be submitted by the crew chief for his crew for each pay period. Comments under "Remarks" should be brief but informative.

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FOREST SURVEY

Form No. 26, Rev. 2

BIWEEKLY FIELD PROGRESS REPORT

(To be submitted to Fort Collins at end of each period)

Crew _____ and _____

Period from _____ 195_____ to _____ 195_____

State _____

[illegible]

Indiate approximate area where you will be working during next biweekly

period: _____

Forwarding address: _____

Signature (for mailing checks): _____

SAFETY PRECAUTIONS

DON'T TAKE CHANCES! Eliminate "horseplay" and think SAFETY!

Automobile Travel

1. DRIVE DEFENSIVELY! Expect the other fellow, whether vehicle or pedestrian, to do the worst thing and be prepared to avoid him. Observe all speed regulations and traffic signs.
2. Check cars frequently to keep them in good mechanical condition. Lights, horn, steering, brakes should be kept in proper adjustment at all times.
3. Sound horn on all sharp curves on mountain roads.
4. When descending long steep grades shift to a lower gear at the beginning of the grade.
5. Adjust car speed to the driving conditions. Wet, icy, or snowy roads, and decreased visibility require decreased speed.
6. When following other cars allow at least one car length per 10 miles of speed between yourself and the car ahead. Under slippery road conditions and poor visibility allow more distance.
7. When driving a jeep, be aware of its idiosyncrasies and adjust your driving accordingly.

Woods Travel

1. Walk, don't run in the woods. Travel over brushy, irregular terrain with rocks and down logs can be hazardous.
2. Wear proper clothing. Remove the cuffs from trousers. Trouser legs should be loose enough to avoid binding or cramping of leg action. Wear good quality leather shoes with calked or composition soles.

3. Be watchful of twigs and branches which may cause eye injury. Be especially alert when stepping up to trees which retain their small dead twigs. Keep a sufficient distance behind the man ahead of you to avoid being slapped by branches.
4. Don't take chances by walking across ravines, etc., on small logs.
5. Snakes. Do not put your hands on ledges or under rocks where you cannot see. Be alert as you walk in snake-infested country. Carry a snake bite kit with you.
6. Keep someone posted as to where you plan to work each day, particularly on long hikes into the forest, so that if you do not return in a reasonable time someone can find you.
7. Do not travel at night. If you become lost, settle down some place and wait for daylight. Stumbling around in the dark in the mountains is dangerous.

Hand Tools

1. Hand axe. Carry it in the sheath except when actually using it.
2. Cruisers axe, pulaski, shovel. Carry these at your side, grasping them just behind the head or blade.

General Precautions

1. See that a large first aid kit is in the car and a pocket kit with you while hiking. Know how to use them effectively.
2. See that accident reporting forms are in the glove compartment of the car you are driving.
3. Report all personal injuries on Form C.A. 1. Make out the report at the time of the injury, even though it was not serious enough to disable you for work. Make notations in your diary as to time, place, cause, and extent of injury and witnesses.

HOW MUCH DO YOU KNOW ABOUT THE JEEP?

Most jeep accidents are due to a complete misunderstanding of the peculiarities of this vehicle. The jeep was designed for a specific purpose-- travel over rough terrain. It is used too often in lieu of the sedan type vehicle. How much do you know about the jeep? For instance, do you know:

- a. That a jeep has a higher center of gravity than the conventional vehicle?
- b. That a jeep is 10 inches narrower than the conventional vehicle?
- c. That a jeep has little springing action and that road shock causes the jeep to bounce off the ground?
- d. That a combination of "a," "b," and "c" tends to make the jeep the easiest car there is to overturn?
- e. That the steering mechanism of a jeep is such as to exert a cramping action in turning rather than a smooth turning action, as in the conventional car?
- f. That the steering suspension is such as to result in a locking action when the brakes are applied?
- g. That a combination of "e" and "f" tends to make a jeep harder to keep going in a straight line and more difficult to steer generally?
- h. That "All-Weather" treads on a jeep or any car increase the braking distance on wet road surfaces over 38 percent (as compared to the conventional military nondirectional tread type)?
- i. That a jeep was designed for a specific purpose: travel over rough terrain; that it was not designed for high speed; therefore, as the speed of this vehicle increases, its roadability decreases, and speeds over 40 m.p.h. are dangerous?
- j. That the jeep lacks body protection; and that when it does upset it affords no protection from maiming, crushing injuries to the occupants.
- k. That the jeep is so constructed that you do not sit in it as you do in a conventional car, lowering the center of gravity, you sit on it, thus raising the center of gravity; and that any weight over four persons raises the center of gravity to a dangerous high?
- l. That a jeep has a 4-wheel-drive hook-up; and that the use of this drive on the straightaway increases the incidence of upset should the jeep run off the road onto loose gravel or sand?

CHECKING

The primary purpose of checking all phases of field work is to obtain a measure of the adequacy of training, to insure uniform interpretation of instructions, and to hold technique errors to a minimum.

Generally about one plot per crew per month should be checked, either by the field supervisor or the party chief, or by both together. The locations to be checked should be selected at random.

In general, any errors discovered will fall into one of three classes: errors caused by misinterpretation of instructions, errors resulting from carelessness, and errors of judgment. Any difference between the check and the original work should be classified as above by the inspector. He should take immediate action to correct any errors caused by misinterpretation of instructions, caution against carelessness, and take steps through training to help the fieldmen improve their judgment. Checking also provides the field supervisor with the opportunity of testing the adequacy of instructions in the field manual, and may often lead to suggestions for the clarification of instructions or the improvement of survey techniques.

Checking procedure

Before going into the field, a copy should be made of the field tally sheet, or the original record taken along. Careful note should be made of any items which were not filled out properly and completely. A copy should be made of the directions to follow in reaching the plot. The form should not be referred to again until the check has been completed, unless it is found that considerable time can be saved by dividing the check into logical units, such as bearing tree measurements, sapling

tally, poletimber tree tally, sawtimber tree tally, etc., and the form referred to at the completion of each unit. The checker should follow the directions provided on the plot sheet in traveling to the plot; if they are adequate, no trouble should be encountered in arriving at the plot location. Notes should be kept of observations en route to the plot, such as:

Adequacy of reference point

Markings on reference point

Accuracy of pacing

Accuracy of compass line

After the plot center has been located, the checker should carefully measure and record all plot data on a new plot form plainly marked "check sheet" at the top. Increment borings should be made about 1 inch directly below former boring. This affords the best opportunity for getting at the cause of any wide discrepancies. Special attention should be given to the following:

1. Was the plot center properly located with reference to the aerial photo?
2. Are bearing trees well chosen, properly marked, and accurately recorded?
3. Are any sample trees being omitted due to inaccurate measurements from the center point?
4. Are any cull trees being included as sample trees?
5. Is the point of merchantability being estimated with good judgment?
6. Are diameters being measured 4-1/2 feet above mean ground level?

7. Are any borderline trees being dropped or added because of inaccurate measurements from the plot center?

8. Is species identification correct?

9. Is good judgment being used in making cull estimates?

10. Is good judgment being used in estimating years since death and cause of death for dead trees?

11. Does photo interpretation check with conditions on the ground?

In addition to checking the volume sample plot, checker should also examine the field crew's check of the type mapping.

After completing the check the inspector should fill out the "Location Check Report" and return it with the original and check plot data to Fort Collins where a comparison of the original and check data will be made.

LOCATION CHECK REPORT

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Plot No. _____ Date _____

State _____ Unit _____ County _____

Photo No. _____ Checked by _____

NOTES FOR RELOCATION OF PLOT

- | | |
|--------------------------------------|-----------------------------------|
| 1. Reference point adequate _____ | 5. Sketch map adequate _____ |
| 2. Markings on reference point _____ | 6. Notes adequate _____ |
| 3. Tree marking along line _____ | 7. Accuracy of chaining _____ |
| 4. Record of physical features _____ | 8. Accuracy of compass line _____ |

PLOT RECORD

- | | |
|---|------------------------------------|
| 1. Plot center located correctly _____ | 6. B. H. point correct _____ |
| 2. Bearing trees _____ | 7. Measurement to borderline _____ |
| a. Choice of trees _____ | trees _____ |
| b. Tree marking _____ | 8. Species identification _____ |
| c. Accurately recorded _____ | 9. Judgment in cull _____ |
| 3. Sample trees _____ | estimates _____ |
| a. Omissions _____ | 10. Judgment in mortality _____ |
| b. Accuracy of measurements _____ | estimates _____ |
| c. Cull trees included as _____ | 11. Marking dead trees _____ |
| samples _____ | 12. P. I. check _____ |
| 4. Point of merchantability _____ | a. Type _____ |
| correct _____ | b. Stand-size _____ |
| 5. Sufficient height measurements _____ | c. Density _____ |
| on tally trees _____ | |

Remarks: _____

DUTIES OF FIELD SUPERVISOR

1. Provide direct supervision of field crews, assigning work areas and shifting crews as needed for most efficient conduct of field work.
2. See that all field crews are properly equipped with necessary tools in good working order, and that these tools are properly cared for.
3. Make frequent inspections of work of field crews to insure that work is done accurately, efficiently, and in adherence to the instructions. This will require the inspection of at least one field location per crew per month.
4. Act as liaison between field crews and local forest supervisors and rangers, informing them as to the impending movements of Forest Survey crews in their areas and making advance arrangements for use of forest facilities as needed.
5. Check with field crews to see that vehicles are properly maintained, safety regulations obeyed, and necessary reports and completed work are forwarded to headquarters at biweekly intervals.
6. Assist in training of personnel in field work and photo interpretation.
7. Assist in training, and act as direct supervisor of personnel assigned to compilation of data.
8. Assist as needed in advance planning for Forest Survey, including selection of areas to be worked, photos to be ordered, etc.

LIST OF FIELD EQUIPMENT FOR 2-MAN CREW

- 1 - Stereoscope
- 1 - 6-inch engineers rule (20ths)
- 1 - Staff compass w/ball and socket joint
- 1 - Jacob staff

- 1 - Aneroid barometer (altimeter)
- 1 - Abney hand level
- 1 - Increment borer
- 1 - Timber scribe

- 1 - Photo scale-protractor
- 1 - Prick for pricking points on photos
- 1 - Packsack
- 2 - 20-foot diameter tapes

- 1 - 100-foot plot tape
- 1 - Tatum holder, letter size
- 1 - Hand lens
- 1 - Hand axe

- 1 - First aid kit
- 1 - Snake bite kit
- 1 - Sharpening stone
- 2 - Emery pads

- 6 - Pencils, black, 2H
- 2 - Pencils, Dixon's Best Lake Red, No. 321-1/2
- Erasers, cap
- Memo pads and envelopes

- Plot stakes
- Forest maps

MAINTENANCE AND CARE OF EQUIPMENT

Each fieldman is held responsible for proper care and maintenance of all equipment issued to him.

Field tools

Use tools only for the purpose for which they were made.

After a wet day, dry and clean them.

Keep tools in sheaths and cases when not being used.

Handle steel tapes carefully to avoid kinking and do not step on them. Keep dirt and grit out of the cases.

When working on the plot, place the tools on top of the opened field pack near the plot center. This affords a quick check of all tools when plot work is finished.

Remember, the tools used for plot work are generally precision instruments and are costly to replace.

Vehicles and tools included with them

Don't stretch the horsepower or the toughness of the tires just to drive that last 100 yards up a steep, rocky road or trail. Get out and walk a little sooner.

Make daily inspections of oil, water, and tires. Check battery at least weekly and every time gas or oil is purchased.

Perform minor maintenance jobs as they come up. Don't wait until the car falls apart.

Maintain the proper lubrication and oil change schedules.

Keep tools in their proper places in the vehicles.